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AMERICAN CHEMICAL SOCIETY.

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OCTOBER, 1896.

EDWARD HART, Editor, J. H. LONG, THOMAS B. OSBORNE,

COMMITTEE ON PAPERS AND PUBLICATIONS.

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PAPERS ACCEPTED FOR PUBLICATION:

Notes on the Determination of Phosphorus in Steel and Cast Iron. By George Auchy.

On Some New Forms of Gas Generators. By Thomas H. Norton.

Reduction of Concentrated Sulphuric Acid by Copper. By Chas. Baskerville.

Contribution to the Knowledge of Ruthenocyanides. By Jas. Lewis Howe.

A New Form of Potash Bulb. By M. Gomberg.

Notes on the Estimation of Caffeine. By W. A. Puckner.

The Separation of Thorium from the Other Rare Earths by means of Potassium Trinitride. By L. M. Dennis.

Some New Compounds of Thallium. By L. M. Dennis and Martha Doan, with crystallographic notes by A. C. Gill.

Dipyridine Methylene Iodide and the Non-formation of the Corresponding Monopyridine Products. By S. H. Baer and A. B. Prescott.

Notes on Reinsch's Test for Arsenic and Antimony. By Jas. Lewis Howe and Paul S. Mertins.

THIS BLANK IS INSERTED FOR THE CONVENIENCE OF MEMBERS, AND WHEN FILLED SHOULD BE DETACHED

THIS BLANK IS INSERTED FOR THE CONVENIENCE OF MEMBERS, AND WHEN FILLED SHOULD BE DETACHED AND MAILED TO THE SECRETARY, ALBERT C. HALE, 331 PUTNAM AVE., BROOKLYN, N. Y.

The American Chemical Society.

CONSTITUTION, ART. III, SEC. 2. "Any person who has had adequate training in chemistry may be nominated for election as a member."

SECTION 3. "Any other person interested in the promotion of chemistry may be nominated for election as an Associate. Associates shall have all the privileges of Members except the rights of voting, holding office, and serving on committees."

SECTION 4. "Any person who shall have been nominated in writing by three members of the Society, and whose nomination shall have been endorsed by a majority of the Standing Committee on Nomination to Membership, shall be eligible for election as Member or Associate, as nominated."

BY-LAW 2. "The annual dues for Members and Associates shall be five dollars ($5), payable in advance."

The undersigned members of the American Chemical Society propose

.....*as a*.....*of the Society.*

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.....as a.....of the Society.

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Nominee's Address.....

Occupation.....

Qualifications.....

Qualifications.....

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The undersigned, members of the Committee on Nominations to Membership of the American Chemical Society, recommend the election of.....

as a.....*of the American Chemical Society.*

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Suggestions for the Guidance of Those Filling out Blank Proposals for Membership:

"Please fill out in full the lines "Nominee's Address" and "Occupation." Under "Qualifications" the Society would like to know what degrees the nominee holds and where obtained; what work he has done in theoretical or applied chemistry; what books or papers he has written or published, etc., etc. The members proposing should sign on the upper set of short lines.

Pasteur Monument Committee

OF THE UNITED STATES.

Dr. D. E. Salmon, Chairman. . . . .
Dr. E. A. de Schweinitz, Secretary, Cosmos Club, Washington, D. C.

It has been decided to erect in one of the squares of Paris a monument to the memory of M. Pasteur. The Paris committee has, however, wisely determined that the statue obtained through international effort shall be located at Paris, where it will be seen by the greatest number of his countrymen and also by the greatest number of his admirers from other lands. The Paris committee has for honorary members the President of the Republic and his cabinet, together with about one hundred and sixty of the most prominent officials, scientists and other distinguished citizens of France.

The Paris committee has kindly extended the opportunity to the people of the United States to assist in this tribute of appreciation and love and has authorized the organization of the Pasteur Monument Committee of the United States.

As secretary of this committee for the United States it is my pleasure to ask the members of the American Chemical Society to contribute towards the erection of this monument.

It is scarcely necessary to remind you of the work of this great man, who placed medicine upon a scientific basis, instituted methods and lines of research the results of which have saved millions of dollars worth of property and thousands of lives, and has solved some of the most difficult problems of theoretical chemistry. Men of all branches of science, and especially chemists, should vie with each other in aiding to honor the memory of so grand a man.

The membership of the American Chemical Society is over 1000. If each member will contribute twenty-five or fifty cents to this cause the total sum will be worthy of our Society. Please give this matter your early attention, fill out the attached blank, and return it together with post-office order or check, to Secretary Pasteur Monument Fund, Cosmos Club, Washington, D. C. A numbered receipt will be forwarded to each subscriber.

E. A. DE SCHWEINITZ,
Secretary Pasteur Monument Fund Committee, Cosmos Club.

International Subscription for the Pasteur Monument.

The undersigned subscribes the amount placed opposite his name as a contribution to the international fund for the erection of a monument at Paris to M. PASTEUR.

NAME.	AMOUNT.

Issued with October Number, 1896.

Proceedings.

THIRTEENTH GENERAL MEETING OF THE AMERICAN CHEMICAL SOCIETY.

BUFFALO, N. Y., August 21, 1896.

President Dr. Charles B. Dudley called the meeting to order. Dr. Roswell Park, President of the Buffalo Society of Natural Sciences, welcomed the visiting chemists as follows:

Mr. President and Gentlemen of the Chemical Society: I am very glad to join with my friends in the City of Buffalo in welcoming you here. My idea of what should be said on such an occasion, is that it should be characterized by genuineness rather than eloquence, by brevity rather than length. I am sure we are very glad to see you here. I know that this is the first time the Chemical Society ever met in Buffalo, and we hope that you will like us so well that you will come again. I have on several occasions in time past welcomed associations of citizens here. I tell them we have pleasant weather here always. I was sure in my own mind that you would have it. It is a promise we can safely make anytime in the summer. Buffalo seems to be generally regarded now as the ideal convention city. We have had a convention here of some kind almost every week, and this will continue through September. There are meetings here almost all the time. If you study our statistics you will find us the healthiest city in the country. If you will travel around our streets you will discover we have the most attractive residential city in the country. And in every way, both from our treatment of you and what you see for yourselves, we hope you will feel thoroughly welcome, and thoroughly at home.

It is always proper, I think, on such occasions, to blow our own horn a little bit. I have found so little appreciation of Buffalo abroad, of what Buffalo is, that I am going to say a little to you about Buffalo. It is the sixth commercial city in the world. That is not generally appreciated. A friend of mine went to Boston and while there was talking to a friend of his in that city about Buffalo. The Boston man said, "Buffalo? Is that on Lake Erie or Lake Ontario?" At the same time, we have a much greater tonnage coming into our harbor in one year than comes into Boston harbor. That he overlooked. About 5,000,000 tons of tonnage enter our harbor, and about the same leave our harbor every year. There is only one other city can say this, and that is Liverpool. That is not generally appreciated. Thirteen years ago, when I moved here, the city had about 125,000 inhabitants; now it has a third of a million, so

you can get an idea of how it is growing. We who live here and see the trend of affairs, look forward to a time when there will be but one city to Niagara Falls. We are coming nearer and nearer to that all the time. It is not far off, I assure you.

Now, with all we have and all we can do for you, gentlemen, you certainly are cordially welcome. You will hear more of this, as I expect you will attend the meetings next week, and perhaps be more formally welcomed by the city officials on other occasions; but our homes are opened to you, and everything we can do in any way for you, is cordially placed before you.

To refer just a moment to the scientific aspect of this gathering, I have never had a chance to talk to professional chemists before, and there is one appeal I want to make to you as coming from our profession to yours. Of course we are working in large measure on common ground; especially when it comes to physiological chemistry, and in the chemistry of the fluids, etc., of the body, we are on absolutely common ground; but there is very much we have to rely upon you for, in order to help ourselves forward; and, as one who is eagerly anxious for the discovery of a particular substance, an ideal in our business, which you only can probably furnish, I will make this scientific appeal to you. We have been working for years to find a substance which shall have a germicidal property so far as deleterious agents are concerned, and yet which will not be toxic with the tissues of the human body; a chemical substance whose relative and absolute toxicity are far enough apart to make it a safe substance to use. When we have that, we hope to saturate the human body with the substance which will be at the same time not toxic with the tissues of the larger organs. I do not know whether that time will ever come. It seems to me an ideal substance. I do not know how you, who are so interested in the affairs of the world at large, as well as humanitarians, can make a better discovery than one along the lines I have suggested. It is not for commercial purposes, but purely for the benefit of humanity. You will pardon this little appeal to your chemical abilities; it is the only chance I have ever had to make it.

Permit me only to reiterate what I have said to you about the cordiality of our welcome, our earnest endeavor to extend to you our hospitality, our earnest hope that your first meeting will not only be so successful that you will look back to it hereafter, but will be so pleasant to you that you will want to come here again quite often. (Applause.)

The President.

Dr. Park, The Committee of Arrangements, and Fellow Members of the American Chemical Society: I am sure I voice the sentiment of those who are present when I say that we appreciate this kind welcome, and we thank you for it. I doubt not there are a good many present who can well remember when chemical analysis, except for purely scientific pur-

poses, was a rarity. In my early student days the chemical analyses that were made, except as I say, for such purely scientific purposes, were largely made by the professors in colleges. They were slow. They were very expensive and any business that wanted a chemical analysis, studied quite a while before employing a chemist to make it. That state of affairs is now changed. With the growth of the technical school there has come forward each year a large crop of young, enthusiastic chemists, and with this supply, if I may use the word, has come likewise the necessity for their existence and the work for them. I am not saying anything more than is known to you all when I say that a very large number of commercial ventures and enterprises to-day cannot live without their chemist. The steel works would not be able to maintain themselves a month without a chemist. The sugar industry needs the chemist, the brewing industry, the textile industry, and, indeed, I might go on and enumerate occupation after occupation which is based largely upon the chemist's work. The railroads, as you know, are using chemists, and the cities begin to have their chemists to protect people against fraud and adulteration in products which are for sale. As we all know, agriculture is more and more every day becoming based on chemistry, and our government itself supports one of the best chemical establishments in the world.

Now, this increase in chemists, this increase in their work, this demand for them, has led to another necessity; namely, that the chemists should occasionally look each other in the face, that they should talk things over with each other, that they should profit by each other's work, and that brings us to state what the organization of the Chemical Society is, an organization with something like 1,000 members, an organization which supports a Journal that is published every month, and with some eight or nine local sections located in different parts of the country. This organization must, as we all know, have a place for meetings. We are already having two meetings every year and this year we come to Buffalo, and I may say, that this city is the Mecca to which all scientific men are travelling this year—this city which may almost be called the mother of scientific organizations. I believe that the reorganization of the American Association for the Advancement of Science, one of the oldest scientific organizations in the country as we all know, took place here in Buffalo in 1866, after the war. It had previously had existence but the war injured it, or caused a temporary cessation and the reorganization took place in Buffalo. Thus much for our reason for existence and thus much for our coming here. We appreciate very greatly your kind and gracious welcome. We look forward to an interesting and profitable time. We thank you. (Applause.)

The following papers were then read and discussed :

"Mercuric Chlorothiocyanate," by Charles H. Herty and J. G. Smith. Read by Dr. Herty. Discussed by Messrs. Hart, Prescott and Frankforter.

"The Reduction of Concentrated Sulphuric Acid by Copper," by Charles Baskerville. Read by the author.

"Notes on the Preparation of Glucinum," by Edward Hart. (An informal description of the progress of work on the preparation of glucinum and its alloys. A glucina crucible was exhibited and also some nearly pure glucina prepared by the method already described in the Journal, **17**, 604. This glucina apparently contains the same unknown substance already detected by Kruss, and as 200 pounds of beryl are being operated on it is hoped that enough may be obtained for its identification.) The paper was discussed by Messrs C. B. Dudley and Hart.

"The Inspection and Sanitary Analysis of Ice," by C. L. Kennicott. Read by the author. Discussed by Messrs. W. P. Mason, Cochran, McKenna, W. A. Noyes, Breneman, Miller, Phillips, Robbins, Frankforter and C. B. Dudley.

"A New Form of Potash Bulb," by M. Gomberg. Read by Dr. Prescott. Discussed by Mr. Phillips.

"Morphine in Putrefactive Tissue," by H. T. Smith. Read by Dr. Prescott. Discussed by Mr. Miller.

"Some New Compounds of Thallium," by L. M. Dennis and Martha Doan, with crystallographic notes by A. C. Gill. Read by Dr. Dennis. Discussed by Messrs. Prescott, Hart, Frankforter and Mason.

The President: It has reached pretty nearly the hour of adjournment and I would like to make an announcement or two as to the work of the Society during the interim. Early in the spring a letter was received by the Society stating that Cannizzaro's seventieth birthday was to occur on the 11th of July, and it was proposed to make a testimonial to him in some way. This letter asked the cooperation of the American Chemical Society. After talking the matter over it was decided since Cannizzaro was already an honorary member that we should send him a testimonial engrossed on parchment. This was duly prepared and was sent in time to reach Rome some two or three weeks before his birthday. However, since that time we have received a second letter stating that owing to the fact that most of the professional people who were interested in Cannizzaro were out of town during the very warm season, it has been decided to postpone the public recognition of the occasion until later in the fall, I think some time in October. So we have not as yet heard

from the other side as to what has been done with the testimonial. I would say likewise that in this letter there was a statement to the effect that the form, which recognition was taking on the other side was that of accumulating a fund to be used for some scientific purpose.

I would also state that at the last meeting of the Society in Cleveland a committee of three was appointed to take up the question of coal analysis. That committee consisted of Mr. Hillebrand of the Coast Survey, Chairman, Prof. W. A. Noyes and the President of the Society. The committee has been able to do very little thus far except to get ready. They are not prepared to make any formal report at this meeting, partly, I think due to my own fault in the matter. Our progress has not been sufficient to make a formal report. This is simply to let you know that the subject has not been dropped.

About the beginning of the summer a paper was read in the New York Section by Prof. Leeds on the color of water, and at his suggestion a Committee was appointed to report to the Society, a standard to be used for determining the color of water and a method. That committee consists of Prof. Leeds, Chairman, Prof. Mason and Mr. Allen Hazen, formerly connected with the State Board of Health of Massachusetts, who has done a good deal of work on water analysis. We have some regular or standing committees; I have not been able to get in communication with the Chairmen of all of them as yet, and we will try to-morrow to see whether we can get information from them on the state of the subjects committed to them. After some announcements by the general secretary and the local committee of arrangements, the session adjourned.

SATURDAY MORNING, AUGUST 22, 1896.

The President called the Convention to order at 9:40 o'clock.

The President: As we have considerable to get through with to-day I think we had better start as soon as possible and first of all I will ask the Society to give two or three minutes to Dr. de Schweinitz who wants to present the matter of the Pasteur monument.

Dr. de Schweinitz: Mr. President and gentlemen of the

Society: I only desire to detain you for a moment to ask for subscriptions towards the erection of an international monument in Paris to Pasteur. The French Government has organized this movement and requested the cooperation of all scientists, or I should say, rather, of all members of the different branches of science in the United States. As Pasteur was a chemist, the chemists of the United States should be the first to respond to this request. Printed blanks of a general announcement, giving the names of the members of the French committee, and also of the organizing committee of Washington, which has been started, will be distributed, and in addition to this subscription blanks, as you see here, upon which you are requested to place the amount, however small, it does not make any difference, and however large, the larger the better and the more will the contribution be appreciated, to be forwarded to Washington. These blanks with the names and the amounts will be preserved and will be deposited in Paris in the archives in connection with this Pasteur monument. I will distribute these blanks and be greatly obliged to the members of this Society if they will join in the contribution at as early a date as possible and to the largest amount that they feel able to give.

The President: I am sure the appeal is one that we are all interested in, and if chemists can see their way to subscribe for this purpose, we shall be very glad. We all feel willing undoubtedly, but possibly not all of us are able.

Dr. de Schweinitz: Mr. President, I might add that the subscriptions so far received have varied in amount from twenty-five cents up, so that no one need have any hesitancy on that subject.

The President: I presume there is no one can not subscribe at least the minimum amount.

I wish to say that Dr. Levi has brought up a few samples of aniline colors made at the aniline works, which there was no opportunity to distribute yesterday, and anyone here can avail himself of the samples if he so desires.

The following papers were then read and discussed:

"Contribution to the Knowledge of Rutheno Cyanides," by James Lewis Howe. Read by the author.

"Analytical Methods Involving the Use of Hydrogen Dioxide," by B. B. Ross. Read by the author.

Prof. Hart: Mr. Chairman, while we are waiting for Prof. Ross to place these figures on the blackboard, there is a matter that has been called to my attention which I would like to present to you; it will only take a half minute; this is connected with the subject of advertising for the Journal. By resolution of the Board of Directors I was appointed a committee of one to secure advertisements for the Journal. This is an important source of revenue, and we have derived considerable money to be applied to the publication of the Journal in this way. It is believed that with some additional assistance this source of revenue can be still further increased. We have to depend for this assistance on voluntary aid, and I wish to acknowledge the great assistance I have already received from Dr. McMurtrie in this direction. The Society is indebted to him more than is perhaps generally known. It has been suggested to me that a number of members of the Society would be willing to assist in the matter of procuring advertisements, and that it would be well to increase the committee to ten members. These members would then feel that it was their duty to assist in securing the advertisements, and it is believed that this will result in securing considerable additional patronage. I therefore move that the President have power to increase the committee to not more than ten members.

Dr. Hale: I second the motion.

Dr. McMurtrie: I think it might be well further to give the committee power to extend its membership in case that appears desirable. I would move to amend in that manner.

Prof. Hart: I accept the amendment.

President Dudley put the motion as amended, and it was duly carried.

The following papers were then read:

"The Estimation of Thoria; Chemical Analysis of Monazite Sand," by Charles Glaser. Read by Dr. Hart.

"The Estimation of Thorium and its Separation from Other Rare Earths," by L. M. Dennis. Read by the author. These two papers were discussed by F. W. Clarke and L. M. Dennis.

"A Complete Analysis of Phytolacca Decandra," by G. B. Frankforter and Francis Ramaley Read by Mr. Frankforter.

"The Crystallized Salts of Phytolacca Decandra," by G. B. Frankforter and Francis Ramaley. Read by Mr. Frankforter. Discussed by A. B. Prescott.

"The By-Products formed in the Conversion of Narcoline into Narceine," by G. B. Frankforter. Read by the author.

"The Composition of American Kaolins," by C. F. Mabery and Otis T. Klooz. Read by Dr. Hart. Discussed by Messrs. Dudley, Baskerville, McMurtrie, Noyes, Prochazka, Breneman and Patrick.

The following papers were read by title:

"Composition of Certain Mineral Waters in Northwestern Pennsylvania," by A. E. Robinson and Charles F. Mabery.

"Zirconium Oxalates," by F. P. Venable and Charles Baskerville.

"Aluminum Analysis," by James Otis Handy.

"An Analytical Investigation of the Hydrolysis of Starch by Acids," by George W. Rolfe and George Defren.

"The Effect of an Excess of Reagent in the Precipitation of Barium Sulphate," by C. W. Foulk. Discussion by T. M. Gladding.

"Determination of Reducing Sugars in Terms of Cupric Oxide," by George Defren.

"Acidity of Milk Increased by Boracic Acid," by E. H. Farrington.

"The Actual Accuracy of Chemical Analysis," by Frederic P. Dewey.

"Some Extensions of the Plaster of Paris Method in Blowpipe Analysis," by W. W. Andrews.

"Device for Rapidly Measuring and Discharging a Definite Amount of Liquid," by Edward L. Smith.

"Table of Factors," by E. H. Miller.

"A Modified Form of the Ebullioscope," by H. W. Wiley.

"The Signification of Soil Analysis," by H. W. Wiley.

"Notes on the Determination of Phosphorus in Steel and Cast Iron," by George Auchy.

"The Development of Smokeless Powder," by C. E. Munroe.

The President: I would like to announce that the winter meeting will be held in Troy, it having been decided by the Council,

on the invitation of our membership in Troy to hold the meeting at that place. We are hoping to make that meeting one of the best the Society has ever had and I would like to ask Prof. Mason to give us a word or two in regard to our meeting next winter at Troy.

Prof. Mason : Mr. President and fellow members, it has been very gratifying to me to learn that you have decided to come to Troy. We are not a large city, but we will do our very best to make your stay agreeable. There are some things there that are worth seeing. We will be able to show you the largest gun plant in the world, much larger than Krupp's. Of course when you speak about Krupp's plant it means his whole concern, the gun plant and that for other varieties of iron and steel manufacture as well, but the gun portion of his plant would go into a small part of the United States gun plant which you will see at Troy. As you know, all the artillery now used by the army is made there, practically ; I believe there are a few unfinished contracts out, but I am not positive about that. You will be able to see electric cranes that I think are larger than you have ever seen elsewhere. You will be able to see guns in all stages of manufacture. I hope you will be able to see an old-fashioned smooth bore of fifteen or twenty inches caliber lying along side of a modern twelve or thirteen. It looks like a soda water bottle. We have some other institutions there that we are proud of, for instance the new basic steel plant, which will be in full operation by the time you get there, the Burden Iron Works where they make Burden's best iron, which you have often heard of. The shirt foundries and collar smelting works with their attendants are well worth seeing. (Laughter.) More particularly the E & W Collar. You have probably heard of them. They have sent you a special invitation. We have N + 1 breweries in Troy. We can take care of the N and we have assigned the 1 to our President. (Laughter.)

It will give us great pleasure to see you and I am heartily glad that you are coming and the Mayor of the city sends his especial invitation.

The President : I am sure we will all look forward to this

meeting with a great deal of interest, and as I said at the very outset we hope to make this the most important meeting the Society has ever had. At this point and *a propos* here I want to give you a word of exhortation in regard to the condition of the society. As everybody knows the most important thing in the Society is the Journal. The Journal is impossible without money. Our rates are low, our annual dues being only $5.00. The Society of Civil Engineers in this country charges $15.00, the Mechanical Engineers $15.00, the Mining Engineers $10.00, the Mining Institute of Great Britain two guineas; the German Mining and Steel Institute charges $10.00. We are trying to run a Society on $5.00 and the management does not think at present that it would be advisable to raise that figure. But we want more money. How can we get more money? Obviously by getting more members. If every member of the Society would get one, think what would happen the doubling of our membership. It is believed there are something like 5,000 chemists in the United States who are eligible, either as full members or associates. We have practically now about 1,000. Your management has in mind plans in regard to the advancement of the Journal to make it still more representative, having it cover wider fields, but for this purpose money is necessary, and money with our present ideas in regard to our present society can only come to us, at least as far as we can see, through increase in membership. Will not every member of the society do something in the next four or five months to increase our membership. We certainly are well established on a good foundation. It is an honor to be a member of our society. We give a full requital for everything we get from our membership, and certainly the time is fast approaching when any American chemist who expects to keep up with his profession cannot afford to be outside of the Society. Let every member bring one member with him and more if possible, at the Troy meeting or bring them in between now and then. I will call upon the Secretary for a few announcements connected with the Society.

The Secretary: Perhaps I might say, Mr. President, that Dr. Mason with becoming modesty has failed to remind you that the oldest institution, if I am not mistaken, for the education of

civil engineers, is in Troy, and as a representative of the institution, he has some modesty in speaking of it. Allow me to call attention to one point in reference to increase in membership; there is provided in the constitution a class of members who are not necessarily chemists, but who are interested in chemistry, the associates; and it would seem as though there might be a large amount of recruiting from this source. There are very many people who do not feel themselves distinctively chemists and yet they are interested either through their business or by their inclination in the development of chemistry; and it would seem possible to have as large a membership of associates as of active members. We can do a good work in that way, and the $5.00 of an associate is worth just as much as the $5.00 of an active member.

In regard to the membership of the society, I would say that last spring, somewhere about March, I think, for the first time in the history of the Society, we struck a membership of a full round 1000 in number. (Applause.)

The President: I am sure those of us who have the pleasure of being at this meeting can not fail to have recognized that there has been at the helm some guiding hands, and I am going to say for your information that those guiding hands are not the officers of the Society but the local committee. I feel that it would be improper for us to close the meeting without some recognition of the kindness we have received at the hands of our members here and also those who have contributed to our happiness during this visit. I will call upon Prof. Mason to propose due recognition.

Prof. Mason: Mr. President and Gentlemen; it seems to me entirely fitting that we should pass a vote of thanks to those who have so kindly looked after our pleasure and interest, and I will therefore move you that the thanks of this society are due to the local committee of arrangements, Drs. H. M. Hill, J. A. Miller, T. B. Carpenter, L. E. Levi, also to the local committee of the American Association for the Advancement of Science, especially Mr. Eben P. Dorr, Secretary, also to the local press and to the managers and directors of the various works visited; namely, the Milsom Rendering and Fertilizing Works, Garbage Reduction

Works, Lang's Brewery, Buffalo Reduction Company, Calcium Carbide Works (Niagara Works), Cataract Construction Company, Cliff Paper Mill, Tonawanda Iron and Steel Company, Schoellkopf Aniline and Chemical Company, Crystal Water Company, also Jaeger's Roof Garden and Café.

The President put the question on the adoption of the motion, which was carried unanimously.

The President: Is there any further information desired or any further question to come up?

Prof. Mason: May I ask this question: Is it possible to so arrange matters as to consolidate the summer meetings of the Chemical Society and Section C? I ask it because I personally can be away but a week. The two meetings occupy more than a week. I should like to attend the two meetings in full, but I can not do it. My position is such that I am obliged to return next Wednesday night. The result is I cut off half nearly of the American Association meeting. Inasmuch as it is a meeting of almost the same men under different names, is it not possible to so arrange matters as to have them all together.

Dr. Norton: I feel very much as Dr. Mason does. In order to bring this to decisive action I move you that the Council be authorized to use its discretion in arranging for a joint meeting of this society and Section C of the American Association next year. I think this will enable us to give an expression to our feelings and leave the Council free to take the proper measures. I know a number of our members are coming on next week. They do not feel as though they could give nine or ten days to the meeting of both societies. There are a number present in the room who will have to leave next Monday or Tuesday. By a little careful study we can arrange to have the whole chemical work that would come before the Society and before Section C of the American Association, carried on in the sessions of the five days which are given up for that purpose. I think it would be much more desirable because we do not want our membership stringing along through some seven days, part of us listening to papers now, and part at the end of the week. I feel from conversation with a number of our members that there is a general belief that we ought to have some simple arrangement for joint

meetings, and they can be presided over alternately by the President of our Society and the vice-president of Section C.

Mr. Prescott: I second the motion, and I think at the present time when the meetings of the Association are as they are, that the plan can be carried out much better than it would have been before the present arrangement had taken place.

Prof. Hart: I second the motion, Mr. President, but I wish to point out one matter that ought to be thought of, that is, the increasing number of papers. We have ten more papers at this meeting than we had last year, and most of you have already received programs of Section C of the American Association and can see what an enormous program that is. People who take the trouble and pains to prepare papers for these meetings naturally feel that they would like to have the papers read. That is a thing to which we should give careful recognition. If anything of the kind is done it is not possible, I think, to secure any more time in Section C than we have now, and according to the printed program that time is already taken up. We have not read more than one-half the papers.

Prof. Kennicott: It does not seem to me it would be a wise thing to sink our identity in any other society. Simply to meet with Section C would seem to me to be loss of identity.

Dr. Hale: Mr. President, it seems to me the motion that has been made is eminently a proper one. The various points one way or the other of difficulty or ease of adjustment would come properly before the Council for consideration and they would have plenty of time to confer with one another and consider the subject. Certain it is that we have a large number of chemists who are increasingly loyal and devoted both to the American Chemical Society and Section C, and by bringing the chemists together at this time we have undoubtedly added to the attendance and the interest and the number of papers of both. It seems to me that the whole subject is wisely referred to the Council of the Society, and of course Section C can take whatever similar action it chooses.

Mr. Breneman: I am quite in accord with the resolution, but it seems to me it would simplify matters very much if we should simply decide to abolish the summer meeting and let the

winter meeting be the only one. That is the annual meeting; it is the meeting where the election occurs and the one of greatest interest. I do not see any reason for a joint meeting. If the arrangement suggested is made, the winter meeting will be distinctive and the only annual meeting of the society.

Prof. Kennicott: I see that my predictions are to be verified. We have already started to sink the identity of the Society. A great many members would be unable to attend any meeting in the winter.

Dr. Prescott: Mr. President, I think the Council would be very glad if we could have a general expression of opinion like that of Prof. Kennicott and others very briefly at this time.

Dr. Howe: The suggestion that has been made is one I remember when the original discussion took place in regard to the reorganization of the Chemical Society. It was proposed at that time that the American Chemical Society should have its winter meeting, but that the summer meeting should not be for the reading of papers; that the papers then should be read at the meeting of the American Association. It certainly is not desirable to carry on any merging of identity, at the same time it seems to me that the plan suggested would be a valuable one to those of us who are present here as chemists, and more valuable than the present plan, if we can mass together all the papers and have all the members present in a four days' session, so that we could have the fullest and most helpful discussion. Some of us are unfortunately unable to be present at the winter meeting, but I think even for us it would be better if all the papers were presented together in the meeting of the American Association in the summer. It does not seem to me we want to do anything to injure the American Association or have things in such a situation that we feel obliged to come here this week and go off next week and miss everything that goes on in the Association. I think the Association owes a great deal to the Chemical Society for what it has done in stirring up an interest again in Section C. I think there should be some amicable arrangement of this matter.

Prof. Mason: Just one word I would like to say. We come here, it is true, to listen to chemical papers, but we also come to

meet chemists, and if we have an opportunity of meeting all the members of the American Chemical Society and the members of Section C as well, we fulfil the second object we came for better than if we should string the meeting over so many days, and as a result one man goes before another arrives and perhaps they want to see each other.

Dr. McMurtrie: Mr. Chairman, there are some difficulties that occur to me in this connection. The matter has been of course discussed a good deal during the past three or four or five years; it had been when the reorganization of the Chemical Society occurred, and one of the important difficulties has arisen to my mind during the last year or so when I have been more or less active in the work of Section C of the American Association. In preparing the program of proceedings for last year I was reminded that it was impossible to have papers presented in the meetings of Section C by any other than members of the American Association. Now there is a larger portion of the membership of the American Chemical Society who are not members of Section C. The consolidation of the meetings will necessarily rule out those men from participation in the meeting. This point would of course be brought before the Council in a discussion of the matter, and would, I suppose, have weight. There are a good many members of the Chemical Society, I know, who feel that they do not care to have membership in the American Association, and it seems to me that in any action we take in this regard their wishes should be carefully considered. I think it might be possible to arrange to have the meetings succeed each other in the same week, but that arrangement which has been followed in the past year, has been objected to by the officers of the American Association, holding that it interfered in a large measure with the work of the Association. It was in a measure on this account that the meetings of the Association are fixed for the week continuously; that is beginning with Monday. So that those societies which are called by the officers of the Association, affiliated societies might have their meeting either in the week preceding or succeeding the meeting of the Association. There seems to be a feeling, I think, among a good many of the officers of the Association that it would be in a measure

impossible to secure the coalescence of the different societies with the similar sections. As I say, all these points will be brought necessarily before the Council in the discussion of the matter, and it is the only way in which it can be determined after all. It must, under the constitution, go before the Council before it is open again to be brought before the Society.

Mr. Cochran: Before the question is put I would like to ask one question, and that is this: I myself see some objections to it, but I do want to attain it; I would like to attend both meetings if I could; I would like to be here when all the chemists are here. This year particularly, my time is very limited; I shall leave Buffalo this evening and be cut out of the meetings next week entirely. The question I wanted to ask is this: Is it impossible that both meetings should run on at the same time? Could we not have a section meeting or the meeting of the American Chemical Society conducted at the same time that the meeting of Section C of the American Association is conducted? The programs are large. Some of us would desire to hear papers in one section one week and some in the other, and in that way we could save our time and get the papers presented so that we could all hear them. I know there are objections to it, but at the same time I desire to have the subject considered.

Dr. McMurtrie: We are not alone in this matter. Nearly all the other sections of the Association are in about the same position, and it is coming to be a serious question as to what shall be done in this matter, whether the American Association shall be taken into a confederation of scientific societies, or whether some such plan as is suggested now shall be carried out. It seems to me that this might be permitted to grow into a confederation.

The President: I was about to remark on that same subject that there are other affiliated bodies exactly in the same position as Dr. McMurtrie has said, so that it is obvious this question is a serious one.

The President put the question and it was adopted.

Dr. Norton: Mr. President, I would like to say a few words as to what has been said in regard to the pleasure and profit we have all had in meeting together as a Society during the past few days, and I feel that our success, which is actually a marked one this year in point of attendance and interest, is due not only to the efforts of our Local Committee, but also to the able preparation made in advance for the meeting by the officers of the Society, and I would therefore like to move before we separate to-day, that the cordial thanks of the Society be expressed to the President and Secretary for the measures which they have taken to render this meeting so successful, and I would like to ask the Nestor of the Society, Dr. Prescott, to put that motion.

Dr. Prescott: I am very glad to place this motion before you and have an opportunity to vote for it.

Dr. Prescott put the motion which was unanimously carried.

The President: In behalf of the officers, I will only say that it is a regret on their part that most of us are so busy with our daily life that we can not give all that is in our hearts and minds to do for the interests of the Society, and we thank you for your vote. (Applause).

The President: I declare then the meeting adjourned until the Troy meeting.

ANNOUNCEMENT.

All persons who have papers to offer for the next general meeting, which will be held the latter part of December in Troy, N. Y., are requested to forward at their *earliest opportunity* an abstract, or the full manuscript of their papers together with titles and names of authors to the General Secretary, Albert C. Hale, 551 Putnam Ave., Brooklyn, N. Y., so that the papers may all be passed upon by the committee on papers and publications in time for announcement upon the program which must be in print before the meeting.

CHANGES OF ADDRESS.

Burt, M. C., 106 Chestnut St., Springfield, Mass.

Conradson, P. H., Franklin, Pa.

Eakins, L. G., care of Guppenheim Smelting Co., Perth Amboy, N. J.

Lane, Henry M., care of Washington Agricultural College, Pullman, Wash.

Mar, F. W., 32 McDonough St., Brooklyn, N. Y.

McCrae, John, 7 Kirklee Gardens, Kelvinside, Glasgow, Scotland.

Welles, Albert H., 635 Quincy Ave., Scranton, Pa.

Whitehead, Robt. L., Box 142, Mt. Washington, Md.

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SOME EXTENSIONS OF THE PLASTER OF PARIS METHOD IN BLOWPIPE ANALYSIS.

BY W. W. ANDREWS.

Received August 7, 1896.

IN the years 1883 and 1884 two papers were published by Dr. Eugene Haanel, of Victoria College, Cobourg, Ontario, now of Syracuse University, in the Proceedings of the Royal Society of Canada, in which he described the brilliant results he was able to obtain in the production of the Bunsen iodide films on the blowpipe support then proposed for the first time; namely, thin tablets of plaster of Paris made by casting sheets three-sixteenths of an inch thick on panes of glass and scratching them, before hardening, with ruled lines, so that when set they would readily break into oblongs measuring two and one-half by one and one-quarter inches. The pure white and highly polished surface of these tablets and its great power of condensing heated gases and exhibiting the true colors, their cheapness, thermal and hygroscopic properties of the tablets, the ease with which they may be prepared and carried, and the excellence of the results when the sublimed iodides, bromides, oxides and sulphides are deposited as coatings upon them, make them an ideal form of support in blowpipe work.

A small pit is made at one end of the tablet somewhat larger than a pin's head, and in this the ore to be tested is heated. The oxide coatings are produced by heating the substance *per se*, the bromides by adding to the substance a drop of fuming hydrobromic acid, and the iodides by adding a strong solution

of hydriodic acid (made by dissolving five ounces of metallic iodine in seven ounces of water, by passing a steady stream of hydrogen sulphide through the solution while the iodine is slowly added). All who have experimented with this solution will be ready to admit that it yields superb results, but though easily renewable when one is near a hydrogen sulphide generator it is very unstable, takes a long time to prepare and is troublesome to carry.

In 1890 Mr. F. A. Bowman read a paper before the Nova Scotia Natural History Society, in which was described a search for a solid reagent to replace the hydrogen iodide solution. He found that potassium hydrogen sulphide or any alkaline sulphate, which does not yield a coating of its own, mixed with potassium iodide would do very well. He also found that microcosmic salt and potassium iodide gave good results. This mixture is a favorite one with some blowpipe experts. Tin is the only metal in the three series of the periodic table, beginning with copper, silver and gold, which does not yield a characteristic coating with this reagent.

The writer has not been able to find whether there have been any other reagents besides these seriously proposed. Plaster of Paris as a support is mentioned in Moses and Parsons' late work as an alternative to charcoal. This is, as far as known to the writer, the only standard work, in which the colors of the films on the tablets are described.

In the rapid development of other methods in chemical work the blowpipe has fallen largely into disuse, and for many years, besides the work outlined above and that of Col. Ross and some valuable tests for individual elements proposed by Chapman, little or no advance has been made. There are two possible lines of future progress in blowpiping, one in the direction of increased power and simplicity, so as to make the method more valuable for the field work of the mineralogist, geologist and prospector, and the other in the direction of increased range and delicacy until the dry way tests rival the delicacy and distinctiveness of the wet tests, as they surpass them in expeditiousness. It may not be amiss, therefore, to call attention to the instrument of Plattner and Berzelius, which, in its mod-

ern form as the hot-blast blowpipe and with the new support and the new reagents and reactions now known to chemistry, is an instrument surpassed by the electric furnace only.

The cleanliness of the method here described, as compared with the charcoal method and the quickness with which sure results can be obtained with very small amounts, should call the blowpipe back to the table of the chemist for preliminary and confirmatory tests, to class work as an accompaniment of the wet methods, and to the lecture table for the purposes of illustration. It is possible to detect five or six metals in presence of each other on one tablet. Many of the coatings are permanent and are all renewable on reheating with addition of a drop of the reagent, so that a set of tablets carefully labelled with a pencil forms a permanent record of a set of experiments. The value of this to the practical chemist and to the student need not be emphasized. It may be noted that blowpiping is so much of an art that new methods are seldom well enough practiced, by those who have become skillful in other methods, to reveal their value.

The extensions of the plaster of Paris method here proposed are: A set of new reagents, which yield some new reactions which are of value in detecting elements in the presence of each other, notably gold and copper in very small amounts in the presence of all elements so far experimented with; arsenic, tin and antimony in presence of each other; sulphur in the presence of selenium and tellurium, and chlorine, bromine and iodine in the presence of each other; a new set of film tests which are found to be of great delicacy (the limits of delicacy are now being measured, it being found that gold, one part in one million, and copper, one part in four millions, are easily detectable); a change in the composition of the tablets which does away with the necessity for using platinum wire in the production of the colored glasses with borax and metaphosphoric acid, these being formed on the tablets with a decided gain in facility and delicacy; and lastly several new methods of handling the tablets themselves.

It is evident that solid reagents will always be the more convenient to carry afield, but, in the laboratory, liquids are to be preferred, since they are more readily applied, and when the

assay is heated, the reagent, which has soaked into the tablet, is fed steadily toward the hot portion of the tablet, so that the heated assay is constantly enveloped in the vapor of the reagent. For over two years the writer has used with satisfaction the following reagents, which have been selected from a score of experimental ones. They are stable and almost odorless, can be carried to the field in a solid form and so used if need be, while a few seconds suffice to prepare them in liquid form if it be desired so to use them.

The chief reagent is a saturated solution of iodine in a strong solution of potassium thiocyanate in water. The solution takes place almost instantly and with great absorption of heat. The bottleful now in use has been in use for over two years, a little of one or other of the ingredients being added from time to time as seemed to be required. Exact proportions are not necessary to the efficiency of the reagent. It can be prepared on the field from the solid chemicals at a moment's notice. The brilliancy of the iodide films produced with this solution are not one whit behind those possible with the pure solution of hydriodic acid. Its coatings tend to form in definite bands of color. The spheres of desposition of the iodide and the oxy-iodide are sometimes very well defined. Some striking and important variations are produced by the presence of the potassium thiocyanate, for example, with molybdenum, osmium, iridium, tin, antimony, lead, bismuth, cadmium and mercury.

Dr. Haanel showed in his second paper that by means of hydrobromic acid, copper and iron could be detected at one operation in the presence of each other and in the presence of nickel and cobalt and any other flux-coloring substances. Instead of the fuming acid with its dangerous properties, a mixture in molecular proportions of powdered potassium bromide and metaphosphoric acid, or potassium hydrogen phosphate or sulphate may be used. This, suggested by Bowman's work, suggests further a set of solid reagents, made by using potassium chloride, potassium fluoride and potassium iodide with metaphosphoric acid, and these form a valuable set for special tests. They have the advantage of yielding at once the colored flux and the coatings produced by any volatile matter in the assay.

When heated, the reaction represented by the following general equation takes place: $KX + HPO_3 = KPO_3 + HX$.

These two reagents, the iodine solution and the bromide mixture, suffice for the production of coatings. The following which are used to differentiate them, are dropped upon the oxide or iodide film and colored spots are produced, or the color is discharged to white (technically, *wiped*), or the coating disappears through solution and absorption by the tablet.

Dr. Haanel used ammonium hydroxide and yellow ammonium sulphide for the purpose of testing the solubility of the films and to produce the sulphide spots. Both of these are troublesome to carry, and the latter is objectionable on account of its intolerable odor, its instability and the fact that for its renewal the hydrogen sulphide generator is required. It has been found that a solution of potassium sulphide, strong enough to show a clear amber color, made by dissolving the solid potassium sulphide in water, or by boiling a strong solution of potassium hydroxide with an excess of flowers of sulphur till the solution assumes a blackish color, which on cooling will be amber yellow, fulfils all the required conditions. If through the action of light it is decomposed, all that is necessary for its renewal is to boil the solution and perhaps add a little sulphur. We therefore have a reagent which can be carried as a solid, can be renewed anywhere, is as efficient as the ammonium sulphide solution and is almost odorless.

In the place of ammonium hydroxide a solution of potassium cyanide is used, made a little more stable by the addition of a little ammonium or potassium hydroxide. Besides these the common acids of the laboratory are useful and a solution of potassium thiocyanate.

The potassium thiocyanate solution is used in two ways. It is either dropped on the coating to test its solubility and to note the colors produced after heating, or it is dropped on the tablet before the coating is deposited, and then the hot vapors sweeping over the moist spot, give with some metals characteristic reactions.

Those coatings which are pure white and therefore invisible on the white tablet, are examined on a tablet which has been

smoked in a flame, or on one streaked up the middle by means of a glass rod which has been dipped in a solution of boric and metaphosphoric acids mixed with lampblack or bone charcoal. In this way the coatings may be viewed on a white and on a black surface at the same time.

In order that the colored fluxes may be made on the tablets, the latter must be made more resistant to the dissolving effect of the metaphosphoric acid and the alkali in the borax. If one teaspoonful of boric acid be added to each quart of the water used in making the tablets, they will be found to be denser and to have the necessary quality. Borax can be fused on them without gathering any impurities from the plaster and if metaphosphoric acid be substituted for phosphor salt, we have a flux which will spread upon the tablet and exhibit the colors of all degrees of saturation at the same time. This reagent, first proposed by Ross, who described its reactions, is preferable to microcosmic salt, since, as it contains no volatile matter and melts readily to a clear glass, it will show by effervescence the presence of water or carbon dioxide, or other gas in a mineral. With cobalt it yields a fine violet when cold, which becomes blue on the addition of any of the alkali metals, for which therefore it furnishes a ready test. The only objection to this reagent is the tendency of the sticks to deliquesce, but a piece can be kept in a corked test-tube,[1] which can be readily dried over the flame, if dampness should gather. In dry weather it causes no trouble. Its solvent power is very great and the colors are fine. Ross asserts that silica and zirconia are the only oxides which are not soluble in this flux. The whole operation may be completed in the time usually required to form the bead in the platinum wire loop and the volatile oxide films will be found on the tablet above the glass, where they may be tested with potassium sulphide and the other reagents. One operation, therefore, suffices for the determination of the volatile acid elements, the volatile metal or metals, and flux-coloring metal. Metaphosphoric acid well replaces potassium hydrogen sulphate in the operation as

[1] In this laboratory each student is supplied with a set of very small dipping tubes and a wooden block into which holes are bored for the reception of a set of test-tubes closed with paraffined corks, to hold the reagents.

described in most text-books for the detection of carbon monoxide, carbon dioxide, iron, chlorine, bromine, iodine, nitrogen tetroxide, chlorine tetroxide, sulphur dioxide, hydrogen sulphide, hydrocyanic acid and acetic acid.

DESCRIPTIVE LIST OF REACTIONS OBTAINABLE ON THE TABLETS.

Copper *per se* yields with difficulty a coating of volatilized metal. With the iodine solution it yields a white iodide coating and an emerald green flame. The iodide treated with a drop of potassium sulphide gives with gentle heat a blackish gray, which is removed by greater heat. Potassium cyanide and nitric acid dissolve the sulphide; hydrochloric and sulphuric acids have no effect till heated and then they remove the spot. Potassium thiocyanate applied to the coating has no effect till heated, when a gray spot is shown. Any part of the coating touched with the tip of the flame shows the emerald green flame (Haanel). Metaphosphoric acid glass is greenish-blue when hot and a fine robin's egg blue when cold. Metaphosphoric acid and potassium bromide yield a splendid reddish violet coating of copper bromide (compare osmium). The bromide plus potassium sulphide shows a brown, which if heated turns blackish and then green, not affected by sulphuric acid, but immediately destroyed by a drop of nitric acid.

Copper plus metaphosphoric acid and potassium chloride yields a yellow brown cupric chloride, which, if treated with a drop of potassium thiocyanate, gives a black ring, which, if heated, becomes a black spot. If, before the assay is heated, a drop of nitric acid be placed one-half inch from the assay and a drop of potassium thiocyanate be placed above that, on heating a fine and very volatile blue-black coating is deposited far up the tablet. This blue-black is not affected by acetic acid, is wiped off by sulphuric acid slowly, and immediately by hydrochloric and nitric acid. The formula of this compound will be determined if some method be found, by which it may be collected in quantity. (See chlorine.)

Silver gives *per se* a pinkish gray coating, which touched by the blowpipe flame (flamed) becomes mottled brown. Reduced

globules are often shown. Metaphosphoric acid yields the same coating and a pearl-like glass. The iodine solution yields a pale yellow, paler when cold, and around the assay forms a black, which does not fuse into the tablet (compare lead). Flaming with oxidizing flame yields a mottled brown anywhere on the tablet. This is a very delicate test and as all other coatings are volatile, the flame drives them off and leaves the silver oxide. Potassium sulphide produces a spotted blackish brown, probably potassium silver sulphide, the analogue of ammonium silver oxide, for if treated with a drop of potassium cyanide it immediately disappears, but if it be first heated, the potassium cyanide has no effect. If only one-half of the sulphide spot be touched with the tip of the flame and then the potassium cyanide be applied, the untouched portion will disappear while the other half will remain. Potassium thiocyanate on the iodide wipes it off; when heated the spot turns black, which is not wiped off by potassium cyanide.

Gold is slightly volatile *per se* and more so if a solution of iodine in potassium iodide be used as a reagent, and the result is a fine rose-colored film of the metal. If potassium thiocyanate be present, no volatility is noticed. Gold and the other elements which respond to the new tests will be the subject of another paper.

Zinc *per se* yields a white coating, not very volatile and luminous yellow when hot. Potassium sulphide and potassium thiocyanate produce no visible change on zinc films. The iodide film is a white, which treated in any part with cobalt nitrate solution yields the well-known zincate of cobalt, which is quickly decomposed by a drop of nitric acid (compare tin). This reaction obtained in this way is decisive for zinc, as aluminum and silicon do not volatilize and are therefore not present in the coating. In the metaphosphoric acid glass, zinc causes flashes of light and detonations (Chapman). Metallic zinc sometimes yields *per se* a black sublimate along with the white oxide (compare arsenic.)

Cadmium *per se* yields one of the most beautiful of the oxide films, which consists of a rich brown with black farther away and somewhat iridescent near the assay. Acetic acid does not

affect it; potassium cyanide dissolves it at once (compare cadmium sulphide). Potassium sulphide and potassium thiocyanate yield a scarlet when hot, and bright yellow, cold. This cadmium sulphide is not affected by potassium cyanide, is quickly destroyed by nitric acid, less readily by hydrochloric acid, immediately by acetic acid (compare cadmium oxide), and is not affected by sulphuric acid (compare copper).

The iodide coating is white with well-defined borders, which is easily distinguished in the presence of other white coatings by the *per se* and sulphide reactions. In the assay and near it the sulphide reaction will be seen caused by the potassium thiocyanate in the iodine solution (see sulphur). In metaphosphoric acid cadmium acts like zinc and yields at the same time its oxide coating beyond the glass.

Mercury gives *per se* a very volatile film of mercury snow, which, with a feather, may be swept into a globule. It is not affected by the other reagents.

The iodide coating is a splendid combination of scarlet, yellow, and velvety green. This is caused by the mixing of the green mercurous iodide with the scarlet and yellow forms of the mercuric iodide. The reactions of each kind of iodide may be obtained on the one tablet. The green and the scarlet are the stable forms into which the coating changes on standing. A drop of the reagent or some more of the vapor blown across the coating changes all into the scarlet form. With mercurous iodide, sulphuric acid gives a yellow spot (mercurous sulphate). Potassium hydroxide gives a black; so does ammonium hydroxide, (iodomercurosamine, NH_2Hg_2I), and potassium sulphide. With the mercuric iodide, sulphuric acid increases the amount of the scarlet, potassium hydroxide yields a white, as does ammonium hydroxide (iodomercurosamine) and potassium sulphide, yield a white spot, quickly turning black. The sulphide spot, strange to say, is partially dissolved in nitric and hydrochloric acid, while sulphuric acid turns it brownish. Potassium cyanide yields a black and potassium thiocyanate a dark spot, and if heated both are wholly volatilized (compare lead, bismuth, and silver). Water has no effect on this coating (compare lead), nor

have hydrochloric, nitric, or sulphuric acids. By the last the coating is not readily wetted.

Gallium has not been experimented with. Indium yields a pale yellow iodide coating and a blue flame.

Thallium *per se* yields a feathery brown with white farther away and a green flame (compare arsenic and tellurium). Potassium sulphide gives a terra cotta brown spot with a black ring. Potassium cyanide and potassium thiocyanate have no effect upon it. The iodide film is an egg yellow with a purple black veil farther away. Potassium sulphide gives a rich brown which potassium cyanide darkens. Hydrochloric acid discharges it slowly and yellow is left (compare bismuth and tellurium). Potassium thiocyanate has no effect on the yellow or the black till heated, when it yields a white (compare bismuth, tellurium, tin, and lead). Potassium cyanide dissolves the black but has no effect on the yellow. Sulphuric acid has no effect. A drop of the reagent on the coating heated shows a spreading black and an orange ring.

Carbon yields a sooty coating, which comes better if sulphuric acid or metaphosphoric acid be used upon the assay. In the case of the carbonates, boric oxide or metaphosphoric acid yield an odorless effervescence (Ross, Chapman). Organic acids blacken the tablet when heated.

Silicon. An interesting reaction given by the silicates, especially the hydrous forms, is being investigated. Chapman dissolves a silicate in boric oxide and then precipitates the silica by adding metaphosphoric acid.

Germanium will give a light yellow iodide film, but none has been on hand to experiment with.

Tin gives a slightly volatile coating, showing a trace of brown when hot. Potassium thiocyanate, if dropped on the oxide and strongly heated gives a pale yellowish green, infusible (compare lead). The slight volatility of tin oxide suggests a scale of volatility, of great use in describing the formation of the films on the tablets. The scale runs in the order of increasing volatility: tin, zinc, cadmium, and mercury. Anything less volatile than tin might be classed as non-volatile.

The iodine solution yields a yellow, reddish brown when hot,

the brown fading instantly. Potassium sulphide yields a black with a brown edge, which darkens on heating. Potassium cyanide discharges the color, which turns black on heating, and when strongly heated shows the pale yellowish green (stannous thiocyanate, $Sn(SCN)_2$; compare lead, bismuth, arsenic, mercury and zinc). Water decomposes the film with formation of oxy-iodide.

Cobalt nitrate gives the bluish green, which is not so readily attacked by nitric acid as the zinc green.

Antimony tri- or pentachloride yields with all tin salts a fine purplish blue-black coating, stable in the presence of acids. Potassium thiocyanate decomposes it when heated and forms the pale green.

These tests with iodine, antimony trichloride, and with potassium thiocyanate remove tin from the list of metals determinable with difficulty before the blowpipe. They can be depended on through a wide range of mixtures.

Lead yields *per se* a white and yellow; reddish brown when hot. All lead salts fuse into the tablet with the formation of lead plumbate, one of the constituents of glass. Potassium sulphide produces a brownish black, with reddish brown ring.

The iodine solution gives a film which is chrome yellow, with a band of fainter yellow farther away (oxy-iodide?), and the assay is black. Potassium sulphide yields a spot with the reddish brown edge. Hydrochloric acid destroys the edge at once. Nitric acid wipes the spot off slowly, and sulphuric acid destroys the black and restores the yellow. The very volatile paler yellow on the outer edges is turned to a brighter color by the same treatment (compare mercury). Potassium cyanide produces a slight paleing of the sulphide color. Potassium thiocyanate on the iodide film gives a black ring, which heated becomes a black spot (compare bismuth). Water wipes off the coating (compare mercury, arsenic and silver).

The bromide film made by using potassium bromide and potassium hydrogen sulphate presents some interesting differences. It is white with a trace of yellow, the yellow fusing into the tablet. Potassium sulphide gives a spot, greenish for a moment and then black, on which potassium cyanide and potassium thiocyanate have no effect, but is partly destroyed by hydrochloric

acid, more rapidly by nitric acid, and completely by sulphuric acid. Potassium thiocyanate, placed on the sulphide and heated, gives a black ring ; with greater heat, a yellow, and still greater heat, a greenish gray ring. Potassium cyanide on the iodide film has no effect till heated ; then a white. Potassium thiocyanate has no effect on iodide till heated ; then a yellowish spot appears (compare tin). The sulphide heated becomes grayish black, on which nitric acid and the other acids have no effect (compare copper).

It is a good illustration of Carnelley's law of color that in general the bromide film of any metal resembles the iodide film of an element either in a higher series in its own family or in the same series, in another family toward the left in the natural classification. Thus the bismuth bromide film resembles the iodide film of antimony and lead. Lead bromide resembles tin and thallium iodide. Thallium resembles mercury, and mercury resembles silver in the same way.

Nitrogen with metaphosphoric acid in the nitrates yields an effervescence with the fumes, odor and reactions of nitrogen tetroxide farther up the tablet, and in the cyanides, the odor of hydrocyanic acid. Nitrates with carbonaceous matter yield ammonia, which will cause white fumes to rise from a spot on the tablet moistened with hydrochloric acid. Ross reports that any nitrogen compound with boric oxide yields a tough transparent bead, and with metaphosphoric acid, purple in the reducing flame with manganese dioxide.

Vanadium gives with metaphosphoric acid a pale yellow in the oxidizing flame, and in the reducing flame a green. (Ross).

Phosphorus. A great desideratum in blowpipe analysis is a good test for this element and the phosphates.

Arsenic yields *per se* a brownish black with a white film falling farther away with odor of garlic and blue flame (compare thallium and tellurium). The iodide coat is white and pale yellow; the assay wholly volatile. Potassium sulphide, with a drop of hydrochloric acid, forms the yellow sulphide, little affected by acids. If oxalic acid be applied to a sulphide spot and then hydrochloric acid, no effect is noticeable. The yellow will show up still better next day (compare antimony). If a drop

of potassium thiocyanate be placed on the tablet about one inch above the assay, and between them a drop of nitric acid and the arsenical vapor be blown over them from the assay, there will generally be formed in the edge of the potassium thiocyanate spot a bright bluish green of unknown composition. All common acids except acetic destroy it. It shows well in the presence of salts of tin and antimony. When it does appear it is decisive for arsenic. This iodide film exhibits a very marked repulsive power for water, probably due to the arsenic oxide which forms with it. Potassium iodide with metaphosphoric acid yields more of the yellow than does the iodine solution.

Antimony *per se* yields a white and yellow band and white fumes. Potassium sulphide yields on this an orange brown, which is quickly destroyed by a drop of nitric acid.

The iodide film is a fine orange yellow far away with yellow nearer the assay and abundant white fumes. Potassium sulphide yields, especially when heated, an orange red with a rich brown and then a black beyond the spot. Hydrochloric acid slightly heated destroys it; nitric acid destroys it instantly; so also does its vapor. Potassium thiocyanate wipes the coating, but heated it yields a fine brown, which is permanent when exposed for months. Potassium cyanide wipes the coat. The orange yellow sulphide spot, produced on the iodide film obtained with potassium iodide and metaphosphoric acid, is not so susceptible to the action of nitric acid and is more rapidly destroyed by hydrochloric acid than the one described above.

If arsenic be present with antimony, there will be shown inside the yellowish orange of the iodide film, a fine peachy pink, which is hard to wet. Stannic chloride yields with antimony in most combinations a purplish blue-black, which is remarkably stable (Haanel). It is now being collected in quantity, with a view to the determination of its formula. It will be seen that with the blue with potassium thiocyanate, the rose pink, and the reactions of the sulphide with hydrochloric, nitric and oxalic acids, the presence of arsenic can be easily demonstrated in the presence of antimony and, as far as experiment has gone, in the presence of any other substances.

Bismuth yields *per se* a yellow ring near the assay and often a

brittle globule. Potassium sulphide gives on the white oxide a brownish black which nitric acid destroys and on which hydrochloric acid has little effect till heated, when it removes it completely. Sulphuric acid has no effect. Potassium thiocyanate on the oxide produces a yellow ring, and heated a yellow spot turning black. (It is to be noted that potassium thiocyanate itself when heated or treated with strong acids, shows on the tablet a fine yellow, which further heating renders colorless.)

The iodide film is a splendid combination of chocolate black, crimson and yellow, the assay turning black. Potassium sulphide forms a chocolate black, soluble in nitric acid and not effected by sulphuric acid. The latter acid on the iodide film produces a black and a dull red edge. This is probably the sulphide formed by the reduction of the acid by the decomposition products of the potassium thiocyanate, which fall with the iodides. It has been noticed, however, to happen with no other metal than bismuth. This reaction is very useful in detecting small quantities of bismuth in the presence of other metals giving dark colored films (compare tellurium). Potassium thiocyanate on the iodide wipes it off, forming a yellow ring, but when heated it forms a black spot with a brown ring. Potassium cyanide also wipes the iodide, but when heated forms a dark gray spot. Glacial acetic acid wipes off the yellow and the crimson, but has no effect on the chocolate iodide.

Sulphur. In looking for a better test for sulphur than the ordinary one with soda and a piece of silver, the stability at high temperatures and the two brilliant and characteristic colors of cadmium sulphide attracted attention, and the fact that it is easily formed in the presence of potassium cyanide. To a solution of cadmium bromide, potassium cyanide was added till precipitation took place and then the solution of the precipitate as potassium cadmium cyanide. This, dropped on a fragment of the sulphide and heated, will show on the tablet near the assay a brilliant scarlet when hot, and bright yellow when cold. This is not affected by potassium cyanide (compare cadmium oxide). One great advantage of this is that selenium and tellurium do not yield anything which can be confounded with these colors, selenium giving a grayish brown and tellurium a yellowish

brown. Sulphates may be reduced by potassium cyanide, or by glycerol. A sulphide or sulphate fused with potassium cyanide will, if touched with a drop of ferric chloride, show in the tablet the pinkish red of ferric thiocyanate. The sulphur in the tablet causes no trouble.

Selenium and tellurium are further differentiated from sulphur by their characteristic films, which are tests of great delicacy. Twenty-seven varieties of complex sulphides, such as bournonite, tetrahedrite, stannite, etc., and all of the common sulphides and sulphates, were found to respond to this test at once.

Selenium yields *per se* with characteristic odor and flame a fine reddish brown, almost pure red on the outer edges and black on the inner edges near the assay. Potassium cyanide wipes it off, while potassium thiocyanate has no effect, except that, if it be heated, a very stable red compound is formed (KSeCN ?).

The iodide film forms in color very similar to the *per se* coat, but more volatile. Potassium sulphide yields a yellow. Potassium cyanide wipes the iodide film off instantly, and therefore will reveal the presence of any other element not so affected, whose film might be hidden by the pronounced hues of the selenium film. Potassium thiocyanate has no effect, while it and heat wipe off most other coatings, and therefore will reveal the presence of selenium in obscuring associations, such as lead. Sulphuric acid shows a slight tendency to make this coating darker (compare bismuth).

Tellurium gives *per se* with flame and odor a brownish black with a white film falling nearer the assay (compare arsenic). Sulphuric acid, if gently heated, shows an effervescent pink of tellurium sulphate. Acetic acid wipes off this coat (compare cadmium). So do the potassium cyanide and ammonia fumes. The iodide film is brownish and purplish black, less brown than the *per se* coat. Potassium cyanide wipes it off in the cold. Potassium thiocyanate has no effect on the purple (compare thallium), and slightly dissolves the brown, and if nitric acid be added a yellow appears. Potassium sulphide darkens the coating a little. Sulphuric acid acts as on *per se* film.

Chromium yields an assay which is dark green when hot and

a fine green on cooling. This test can be made very delicate. Metaphosphoric acid gives similar colors.

Molybdenum yields *per se*, and especially by flaming, an ultramarine coating. The oxide film, which forms when the iodine solution is used, comes better by flaming of the film and in presence of vapors of sulphuric acid. A potassium thiocyanate spot, over which the vapors from the assay have swept, exhibits a splendid hyacinthine pink. Metaphosphoric and sulphuric acid vapors aid its formation. It is probably molybdenum thiocyanate ($Mo(SCN)_2$). If potassium thiocyanate be added to the assay this color will spread all around the edges of the blue, extending to a distance of two inches from the assay. This very delicate reaction is of special interest, from the fact that it shows that part of the potassium thiocyanate, or at least the radical thiocyanogen travels undecomposed that distance over the tablet and that all these films are formed in the presence of moist potassium thiocyanate or thiocyanogen vapors, which will account for the behavior of some of the films. This pink is decolorized by ammonia, not restored by nitric acid. Sulphuric acid dropped on the tablet will form a blue ring ($MoSO_4$). Metaphosphoric acid yields blue or bluish green glasses according to the degree of saturation (Ross).

Tungsten and uranium in metaphosphoric in the reducing flame yield, the former a blue and the latter a green glass (Ross).

Fluorine. If a fluoride be mixed with phosphoric acid and a piece of glass be laid on the tablet about two cm. away from the assay, a fine etched semicircle will show itself after the heating of the assay. The radius of the semicircle is about three cm. long.

Manganese yields with metaphosphoric acid a glass, which is violet hot and cold, colorless in the reducing flame, and turning green on the addition of an excess of soda (Chapman, Ross).

Chlorine. Chlorides, bromides and iodides of the alkali metals yield *per se* white coatings, which may be distinguished from other white coatings by their flames and by the action of a small quantity of the coating scraped together and mixed with the

metaphosphoric acid cobalt glass, which will remain blue on cooling.

A compound of chlorine if mixed with metaphosphoric acid and heated, in the reducing flame (if oxy salt), will cause white fumes to rise from a spot moistened with ammonia situated about two cm. above the assay. If a copper salt be present in the glass or near it, so that copper chloride vapors are formed and these are allowed to sweep over a spot of nitric acid and then over one of potassium thiocyanate, near the assay a yellowish brown coating of cupric chloride will form with an azure blue flame, and beyond the potassium thiocyanate spot a fine blue-black, very volatile (see copper).

A bromide with potassium cyanide added to it and the fused mass laid upon a copper glass and a drop of nitric acid added, a fine red will show itself. Bromides with metaphosphoric acid saturated with copper, upon blowing, yield a fine and very volatile reddish violet coating. If a bismuth salt be exposed to the hot vapors, it will yield a yellow coating. The spot on the tablet moistened with starch paste, not too near the assay, will turn yellow.

Similarly treated iodine compounds yield violet vapors, a violet in the glass appearing with effervescence, and with copper salt they yield a white coating, with bismuth scarlet and chocolate, and with starch a bluish black.

Iron gives an iodide film too delicate in color to show up well, either on the white or the black surface. Its presence can be shown by a red coloration after blowing hydrochloric acid vapors over the tablet, to turn all ferrous compounds into ferric, and then adding a drop of potassium thiocyanate to the coating. It is difficult to obtain plaster of Paris sufficiently pure not to give this reaction for iron. Such reaction can, however, be readily distinguished from that given by an assay. Metaphosphoric acid gives a luminous yellow when hot, which is perfectly colorless when cold. A drop of acid on this to produce ferric compounds, followed by a drop of potassium thiocyanate, will show the red of ferric thiocyanate, which is decolorized by phosphoric acid, but not by hydrochloric acid. Made in this way, this test is not too delicate to show the iron of composition. An assay of

iron treated with a drop of sulphuric acid and heated will show on the tablet a film of Venetian red.

Cobalt yields a glass blue hot, and violet cold; permanently blue if alkali be present. Boron trioxide acts similarly. With the iodine solution a spot around the assay turns pink, then deep blue on heating, and then black.

Nickel with boron trioxide separates as green fragments, which may be gathered by solution of the glass in water, and then the separated nickel (as any nickel compound) will yield in metaphosphoric acid, a reddish brown when hot and amber yellow when cold (Ross).

Palladium gives a dull blue-black film with the iodine solution, which is very characteristic. The assay turns dull black.

Osmium yields *per se* a greenish black. The iodide film is a combination of olive green, dove and slate colors, with red appearing around the lower edges. The edge of the coating nearest the assay shows greenish brown and the assay itself will be closely surrounded with an iridescent black film. Potassium sulphide turns the coating somewhat darker, which heated, becomes a brownish film, which is wiped off by hydrochloric and nitric acids and not affected by sulphuric acid and potassium cyanide. On the iodide films sulphuric acid has no effect; potassium thiocyanate has none till heated and then it turns brown. Hydrochloric and nitric acids remove the film. Potassium thiocyanate dropped on the tablet over an inch from the assay before the coating is deposited, will, when the vapors sweep over it, turn to a fine brick red, destroyed by potassium cyanide and the acids.

Potassium bromide and potassium hydrogen sulphate give a pinkish brown (compare copper). Potassium sulphide produces a gray not affected, which turns darker on being heated, destroyed by acids, and not affected by potassium cyanide.

Iridium yields with the iodide solution an indistinct brownish yellow coating and a potassium thiocyanate spot which in tint resembles the molybdenum spot, but it is covered with dots of darker pink.

Platinum gives an infusible gray film. Ruthenium and rhodium are being investigated.

All these reactions have been obtained from a large number of the compounds of each element except in the cases of osmium, indium and iridium. The writer will be glad to hear of any cases in which they fail and to receive specimens of combinations which cannot be unlocked by this method. One gram weight of any alloy is sufficient. The next work to be undertaken is to exhaustively determine the lowest percentage of any metal which can be determined with certainty in the presence of one, two, or any number of other metals, to describe the characteristic effect that one metal has on the coating yielded by another when they are deposited together and to determine the value of each metal as an interfering element.

COVERED TABLETS.

The tablets are easily cut with a knife and therefore they can be used in various ways. Open tube work can be performed on a tablet, if a groove be cut lengthwise of a tablet and laid upon another, groove down. A small pit for the assay is cut in the lower one about one centimeter from the end. The groove is cut so that its narrowest part is just above the assay pit, and from that point to the lower end it flares into a half funnel form and into this the flame is blown. By regulating the size of the groove at its narrowest part the amount of air which will flow over the assay may be regulated. This method is of great use when very small quantities of precipitates are to be tested. For instance, five-tenths mg. of arsenious oxide gave in one experiment a narrow coating one-half inch long on each tablet. This gives ample opportunity for making confirmatory tests. Various reagents may be placed along the groove to be acted on by the vapors, gold leaf for mercury, potassium cadmium cyanide and lead acetate for hydrogen sulphide fumes, starch, bismuth and antimony solutions for iodine, copper sulphate for chlorine, etc.

If a coating be made, or a small piece of volatile salt be placed in a small pit in the tablet and a thin tablet be placed over it, it is found that if potassium sulphide, or potassium thiocyanate be dropped on the upper tablet and the flame be directed upon the drop, they will pass through the tablet and reactions will take place away from the air. After a few seconds blowing the upper tablet will be found to be floating on a layer of hot

gas, which flows between the two smooth surfaces. Tin and arsenic, and other substances easily oxidizing in the air, form their sulphides very readily under these conditions. Potassium thiocyanate forms sulphides. It is in this way possible, by using ammonium hydroxide or hydrochloric acid, to form the sulphides in the presence of moist acid or alkaline vapors.

Other methods of using the tablets will be described later.

In teaching research methods, the plaster of Paris method is one of the finest instruments to use with beginners. In the course of an hour a student will have been able to make from twenty to forty different tests and without any delay in preparing solutions, or in waiting for filtration to take place, he will have produced the oxide, sulphide, chloride, bromide, and iodide of a given metal, and will have noted their colors, manner of deposition, volatility, solubility in several reagents, and the behavior of the assay itself at high temperatures and will have ransacked his vocabulary to find terms to describe the phenomena in his written notes. His skill in manipulation and his powers of observation are kept in liveliest exercise and his independence developed, for it is quite possible to give each student in a large class his own problem. In no other laboratory work do the compelled acts of judgment follow each other as rapidly. There are many problems which may be set requiring reference to standard chemical literature, and many simple and some very difficult equations of reactions to be written.

Not the least valuable consideration from an educational standpoint, is the aesthetic quality of the work. All the coatings are symmetrical in form and beautiful in shading, and many of them in brilliancy of hue and in delicacy of shading, rival the most splendid colors of flowers. This gives added interest to the work and is of great value since adult students are so frequently found to be greatly deficient in the color-sense, as children are not. There has not been opportunity to compare the shades of these films with the descriptions given in the Standard Dictionary. When this has been done, exact training can be given in color language also.

Apology is offered for publishing the results of this research at this stage, when so many unsolved problems stand along its

path, but this much is given in order that the practical value of these reactions and methods may be put to the test.

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AN ANALYTICAL INVESTIGATION OF THE HYDROLYSIS OF STARCH BY ACIDS.

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FEW problems of commercial analysis have been so complicated and so discouraging as that of the determination of the components of starch conversion products. The well-known schemes of commercial analysis of worts and similar products of the action of diastase are based on the assumption that but two simple compounds are formed from the starch—maltose and dextrin. In the case of glucose syrups and starch sugars, which are the results of acid hydrolysis, it is known that the reaction proceeds farther as dextrose is formed from the maltose and dextrin.

Musculus and Gruber[1] decided that these reactions went on together so that except at the very beginning or final stage of hydrolysis all of these compounds must be present in solution.

The analysis of acid-converted starch products must therefore take into consideration the presence of the third compound, dextrose.

Much doubt, however, has been thrown on the accuracy of such analyses, as during the past twenty years the researches of O'Sullivan, Brown, Heron, Morris, Bondonneau, Herzfeld, Musculus, Bruckner, Fischer, and other distinguished investigators, have shown that not only the simple compounds referred to can be isolated from starch products but also many others of quite distinct optical and chemical properties. Space will not permit a review of this work, which is in many points conflicting. The recent conclusion of Lintner and Düll is that the following compounds result from hydrolysis :[2]

[1] *Bull. Soc. Chim.*, **2**, 30.

[2] *Ber. d. chem. Ges.*, **28**, 1522–1531.

Hydrolysis with oxalic acid.	With diastase.
Amylodextrin	Amylodextrin
Erythrodextrin I	Erythrodextrin I
" IIα	.....
" IIβ	.....
Achroodextrin I	Achroodextrin I
" II	" II
Isomaltose	Isomaltose
Dextrose	Maltose

Others, as Brown and Morris,[1] deny the existence of the isomaltose of Fischer and Lintner and Düll, and mention another compound, maltodextrin, an intermediate between dextrin and maltose.

In 1885 Brown and Morris[2] discovered the remarkable law that at any stage of the conversion of starch by diastase, the total product, in its optical properties and relation to Fehling solution, behaved exactly as if made up of two components only, maltose and dextrin, so that it was possible by taking the rotatory power to calculate at once the cupric reducing power if the total carbohydrates were known. This law indicated that, however complicated the bodies isolated, they could be considered as existing in solution as two simple compounds, and did much to establish the validity of the principles of the usual commercial analyses of beer-worts and similar products.

The method of analysis of glucose syrups and starch sugars implies the assumption of a similar law, but the proof that this law actually exists under varying conditions of hydrolysis apparently has not been worked out.[3]

Our investigations have been made, first, to determine whether there was any simple constant relation between the optical rotation and the cupric reducing powers of starch products hydrolyzed under different conditions; and, secondly, whether any laws could be found affecting the three simple bodies assumed to be formed and determined by the usual methods of analysis.

Incidentally we have collected some data as to the speed of hydrolysis, influence of carbohydrates on specific gravity of

[1] *J. Chem. Soc.*, No. 393. Aug., 1895.

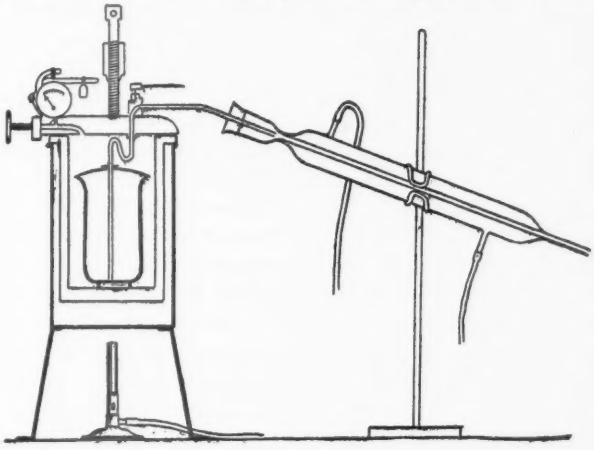
[2] *Ann. Chem.* (Liebig), **231**, 131.

[3] A very complete bibliography of the original publications on the carbohydrates is in *Tollen's Handbuch der Kohlenhydrate*, Vol. I, *1888*, 331–360; Vol. II, *1895*, 368–398.

solutions, and some looking to the adoption of a more rapid and accurate method of determining cupric reducing power by Fehling solution.

The latter data are included in a separate paper. The work on specific gravities is not yet sufficiently complete for publication.

An autoclave of the usual construction was modified in the following manner: The thermometer tube was taken out and in its place was attached a specially constructed valve, by means of which liquor cooking in a beaker in the interior could be removed at any time during the progress of the experiment. This superheated liquor was prevented from vaporizing by passing through a condenser. Excessive condensation into the beaker was prevented in large part by a well fitting lead cap. The illustration sufficiently explains the apparatus.



In most of the work about 100 grams of a good quality of commercial corn starch[1] was mixed with a liter of water con-

[1] An analysis of this starch by the usual commercial methods gave:

	Per cent.
Starch	89.15
Oil	0.14
Ash	0.12
Albuminoid	0.42
Water	10.21
	100.04

taining the hydrolyzing acid. Samples of from fifty to seventy-five cc. of the liquor were removed at different stages of the conversion and immediately shaken up with a few grams of marble dust. Two drops of tenth normal sodium hydroxide solution were then added to the sample, which was cooled and filtered. This method of neutralization, except in cases of very low converted samples, gave an absolutely clear filtrate, the filtration being exceedingly rapid, and the removal of the albuminoids being practically complete. Low-converted products often required to be heated with aluminum hydroxide before filtering.

The samples were tested as follows:

(1) For specific gravity by Westphal Balance, corrected to a temperature of 15.5° C.

(2) Specific rotatory power ($[\alpha]_D$) by a Schmidt and Haensch half-shade saccharimeter.

(3) Cupric reducing power by means of Fehling solution.

Total Solids—Total solids were calculated from the specific gravity of the solution by the factor 0.00386, which was taken to represent the influence of one gram of the mixed carbohydrates in 100 cc. of solution. Corrections were made when necessary for the influence of other substances in solution, not carbohydrates. This factor 386 is practically that of Balling and Brix and has been found exact for approximately ten per cent. solutions of cane sugar, and the balance of evidence seems to be that it is correct for starch products.

We have made several determinations of this factor by drying ten cc. of solution on rolls of dried paper at a temperature of 100–105° C. Our results point to the constancy of this factor 386 even in solutions of low rotatory power, but are not yet complete enough to establish the value for all rotations.

Therefore, in this work we have adopted the expedient used by Brown and Morris, and others, and calculated all optical and copper reduction constants on the assumption that all three carbohydrates in solution affect the specific gravity like cane sugar when the concentration is approximately ten per cent. Even if subsequent investigations show that this view is not exactly correct, the relative values of the constant will not be appreciably affected nor the truth of the laws as set forth.

To illustrate this method of calculation of constants we give the following from our own determinations:

Ten grams of dextrose dissolved in 100 cc. of water gave a rotation of 30.70° on the Schmidt and Haensch saccharimeter. This gives $[\alpha]_D$ as 52.8.[1] As the increase in specific gravity per gram of crystallized dextrose in 100 cc. is 0.00381, $[\alpha]_{D386}$ is 53.5.

9.751 grams of crystallized maltose anhydride in 100 cc. of water gave a rotation of 76.40. This gives an absolute specific rotatory power of 136.6. The specific gravity factor of maltose being 0.00390, $[\alpha]_{D386}$ is 135.2°. No exact figure is known for the influence of crystallized dextrin on the specific gravity of its solution. O'Sullivan gives 0.00385, and the balance of evidence seems to favor this. Hence 195 is probably correct for $[\alpha]_{D386}$.[2]

In like manner the values for K have been reduced to a dextrose with the factor 386.

Specific Rotatory Power.—All readings were made as nearly as possible at a temperature of 20° C. in 200 mm. tubes, the mean of several readings being taken. Corrections for zero-error were made frequently, and the instrument was carefully screened by glass plates from the heat of the lamps. Comparisons were made with a Laurent polariscope to determine the value of the division in terms of angular degrees for sodium light, the accuracy of the quartz wedges having being verified previously. With standard quartz plates the usual factor 0.346 was obtained, but solutions of commercial glucose of approximately ten per cent. gave the figure 0.344, which agrees with the recent work of Rimbach[3] and other investigators. We have taken, therefore, the latter factor in our calculation.

[1] Precautions against bi-rotation were taken in both examples cited.

[2] Brown and Hearn: *Ann. Chem.* (Liebig), **199**, 190–243.

[3] *Ber. d. chem. Ges.*, **27**, 2282.

TABLE A.

COMPARISON OF SCHMIDT AND HAENSCH HALF-SHADE SACCHARIMETER WITH THAT OF LAURENT POLARISCOPE READING IN ANGULAR DEGREES.

	S. and H. saccharimeter. (Using bat-wing burner and lens.)			Laurent polariscope. (Sodium flame.)			
Test.	Reading.	Zero error.	Corrected reading.	Reading.	Zero error.	Corrected reading.	Factor.
(t = 20—22)							
Quartz A	62.965	0.300	62.665	21° 40′	0	21.666°	0.3457
"	62.800	0.150	62.650	21° 40′	0	21.666°	0.3458
"	62.970	0.290	62.680	21° 40.2′	0.6′	21.660°	0.3458
"	62.836	0.130	62.706	21° 40.7′	0.6′	21.666°	0.3455
Glucose A...	77.510	0.277	77.233	26° 35′	0	26.582°	0.3442
" B ...	76.355	0.150	76.205	26° 15.3′	0	26.254°	0.3445
" B ...	76.355	0.150	76.205	26° 14′	0	26.233°	0.3442
" C ...	76.535	0.150	76.385	26° 18′	0	26.300°	0.3443
" D...	76.110	0.130	75.980	26° 10.3′	0.6′	26.162°	0.3443
(t = 25)							
Hydrolized starch products E	92.73[1]	oo	92.73	31° 56′	—1′	31.95°	0.3445
Hydrolized starch products F	24.84	oo	24.84	8° 32′	—1′	8.55°	0.3442

Cupric Reducing Power.—Our method is practically that of O'Sullivan, first published in 1876. The copper is weighed as the oxide. We have found this method exact and rapid. An analytical investigation of this process has been made by one of us and given in detail in a separate paper.

Plotted Results.—To show the relationship of the copper-reducing power, and the specific rotatory power of the products formed during the progress of the hydrolysis of the starch, we have plotted our results, taking as abscissae the decreasing values of the rotatory power, from the amylodextrin stage (195°) to that of dextrose ($[\alpha]_{D_{386}} = 53.5°$), and as ordinates the cupric reducing power (K_{386}) taking that of an equivalent weight of dextrose as 100.[2] [See Plate A.]

[1] Using Welsbach burner.

[2] Data given in Table B.

TABLE B.

HYDROLYSIS OF STARCH. EXPERIMENTAL DATA.

Run.	No. of sample.	Minutes Cooking.	grams starch.	Atmospheric pressure.	Acid. Kind.	Acid. Amount cc.	Water cc.	Sp. gr. 15.5.	Sacch. reading.	Copper oxide.	$[\alpha]_D^{38.6}$.	$K^{38.6}$.
8*a*	2	30	110	2	HCl	$\frac{n}{10}$	10	990	1.0456	98.0	0.1552	142.7	0.4747
	3	45							1.0394	59.3	0.2103	99.95	0.7480
	4	75							1.0374	41.5	0.2275	73.67	0.8537
	5	135							1.0367	32.9	0.2480	59.53	0.9283
10	1	15	110	2	HCl	$\frac{n}{10}$	10	990	1.0199	57.3	0.0060	191.30	0.0412
	2	45							1.0320	84.8	0.0366	176.0	0.1567
	3	75							1.0348	80.7	0.0923	154.0	0.3652
	4	100							1.0315	67.6	0.1026	142.5	0.4523
	5	130							1.0315	60.8	0.1258	128.1	0.5584
	6	160							1.0318	54.6	0.1368	114.0	0.5993
	7	190							1.0318	49.4	0.1594	103.1	0.6995
	8	220							1.0318	44.7	0.1781	93.95	0.7827
	9	250							1.0323	42.2	0.1848	86.66	0.8000
	10	280							1.0323	38.4	0.1940	78.94	0.8407
11	1	15	110	2	HCl	$\frac{n}{10}$	100	900	1.0414	89.55	0.1290	143.6	0.4434
	2	30							1.0417	55.95	0.2320	89.10	0.7825
	3	45							1.0419	41.0	0.2747	64.98	0.9230
	4	60							1.0414	36.0	0.2837	57.75	0.9663
	5	75							1.0412	33.0	0.2830	53.19	0.9685
	6	90							1.0406	32.5	0.2763	53.16	0.9590
13	1	15	110	2	HCl	$\frac{n}{10}$	100	900	1.0394	103.2	0.0056	174.0	0.1958
	2	45							1.0384	75.7	0.1500	129.9	0.5405
	3	60							1.0380	61.1	0.1898	105.7	0.6988
	4	90							1.0380	45.5	0.2339	79.50	0.8646
	5	120							1.0375		0.2448	67.75	0.9175
14	2	22½	110	2	HCl	$\frac{n}{10}$	100	900	1.0379	97.8	0.0661	167.4	0.2415
	3	35							1.0384	85.9	0.1095	148.6	0.3964
	4	52½							1.0370	64.75	0.1664	116.2	0.6279
	5	75							1.0374	50.80	0.2040	90.20	0.7640

HYDROLYSIS OF STARCH. EXPERIMENTAL DATA.

Run.	No. of sample.	Minutes cooking.	grams starch.	Atmospheric pressure.	Acid. Kind.	Acid. Amount cc.	Water cc.	Sp. gr. 15.5.	Sacch. reading	Copper oxide.	$[\alpha]_{D\ 386}$.	K^{386}.
	6	105						1.0374	39.60	0.2281	70.31	0.8561
	7	135						1.0374	34.95	0.2493	62.34	0.9367
15	2	30	110	2	HCl $\frac{n}{10}$	1000		1.0371	88.1	0.0890	157.7	0.3329
	3	60						1.0337	67.05	0.1247	132.1	0.5146
	4	90						1.0337	56.50	0.1551	111.4	0.6421
	5	120						1.0337	46.00	0.1863	90.65	0.7727
16	1	25	110	2	HCl $\frac{n}{10}$	1000		1.0327	79.90	0.0679	162.3	0.2877
	2	40						1.0393	81.40	0.1395	137.5	0.4946
	3	50						1.0380	70.60	0.1617	123.4	0.5936
	4	75						1.0380	57.00	0.1994	99.61	0.7348
17	1	15	55	2	HCl $\frac{n}{10}$	25	475	1.0360	105.5	0.0173	188.5	0.0643
	2	23						1.0341	92.9	0.0344	180.9	0.1393
	3	33						1.0343	88.1	0.0539	170.6	0.2173
	4	42						1.0352	86.2	0.0751	162.7	0.2963
	5	50						1.0308	79.5	0.0828	157.0	0.3396
18	1	75	60	2	HCl $\frac{n}{10}$	50	450	1.0422	74.7	0.1892	117.6	0.6273
	2	90						1.0423	68.0	0.2100	106.8	0.6958
	3	110						1.0428	60.3	0.2369	93.56	0.7796
	4	120						1.0428	52.6	0.2587	81.62	0 8507
	5	135						1.0429	49.2	0.2676	76.05	0.8720
19	1	15	60	2	HCl $\frac{n}{10}$	50	450	1.0383	105.0	0.0329	182.1	0.1186
	2	30						1.0374	87.0	0.0975	154.5	0.3619
	3	40						1.0374	66.2	0.1337	117.6	0.6255
	4	130						1.0359	39.8	0.2272	73.62	0.8882
	5	150						1.0326	34.8	0.2093	70.89	0.8997
20	1	45	60	2	$H_2C_2O_4$ $\frac{n}{10}$	50	450	1.0327	87.2	0.0396	177.1	0.1673
	2	90						1.0301	71.2	0.0766	157.7	0.3526
	3	120						1.0318	65.8	0.1125	135.5	0.4917
21	2	60	60	2	$H_2C_2O_4$ $\frac{n}{10}$	100	400	1.0352	75.9	0.1145	143.2	0.4523

HYDROLYSIS OF STARCH. EXPERIMENTAL DATA.

Run.	No. of sample.	Minutes cooking.	grams starch.	Atmospheric pressure.	Acid. Kind.	Acid. Amount cc.	Water cc.	Sp. gr. 15.5.	Sacch. reading	Copper oxide.	$[\alpha]_D^{386}$.	K_{386}.
	3	75						1.0359	71.6	0.1350	132.4	0.5237
	4	105						1.0355	64.0	0.1577	119.8	0.6200
24	1	30	65	2	HCl $\frac{n}{10}$	100	400	1.0440	88.2	0.1651	133.1	0.5236
	3	60						1.0371	38.1	2x(0.1211)	68.19	0.9080
	4	75						1.0376	33.95	2x(0.1319)	59.95	0.9745
	5	90						1.0406	34.7	2x(0.1388)	56.75	0.9526
25	1	45	65	2	$H_2C_2O_4$ $\frac{n}{10}$	200	300	1.0414	99.7	0.0966	159.9	0.3240
	2	90						1.0448	85.6	0.1799	126.9	0.5611
	3	135						1.0452	67.0	2x(0.1265)	98.42	0.7791
	4	180						1.0458	55.3	2x(0.1401)	80.17	0.8525
	5	225						1.0455	47.7	2x(0.1483)	69.61	0.9088
26	1	30	65	2	H_2SO_4 $\frac{n}{10}$	100	400	1.0447	110.9	0.0869	164.7	0.2760
	2	62						1.0466	89.3	2x(0.0821)	127.3	0.5480
	3	90						1.0478	74.2	2x(0.1227)	103.[illegible]	0.7144
	4	120						1.0500	63.1	2x(0.1475)	83.79	0.8206
	5	150						1.0525	56.4	2x(0.1614)	70.96	0.8848
27	1	10	60	4	HCl $\frac{n}{10}$	50	450	1.0430	95.2	0.1281	147.0	0.4144
	2	20						1.0430	60.85	2x(0.1196)	93.97	0.7738
	3	30						1.0430	42.7	2x(0.1414)	65.94	0.9162
	4	45						1.0430	35.3	2x(0.1466)	54.51	0.9506
	5	60						1.0430	34.8	2x(0.1533)	53.70	0.9968
33	1	10	60	4	HCl $\frac{n}{10}$	100	400	1.0426	60.8	0.2351	94.77	0.7754
	2	15						1.0426	41.4	0.2833	64.54	0.9378
	3	20						1.0423	35.4	0.2919	55.58	0.9736
34	1	10	60	3	HCl $\frac{n}{10}$	200	300	1.0435	56.4	0.2532	86.10	0.8143
35	1	90	60	1	HCl $\frac{n}{10}$	100	400	1.0381	87.6	0.0992	152.7	0.3616
	2	180						1.0391	66.5	0.1887	112.9	0.6751
	3	225						1.0403	49.5	0.2525	81.56	0.8831
39	2	90	60	4	HCl $\frac{n}{10}$	50	450	1.0384	39.7	0.2621	53.01	0.9607
	3	120						1.0378	30.4	0.2628	53.40	0.9779

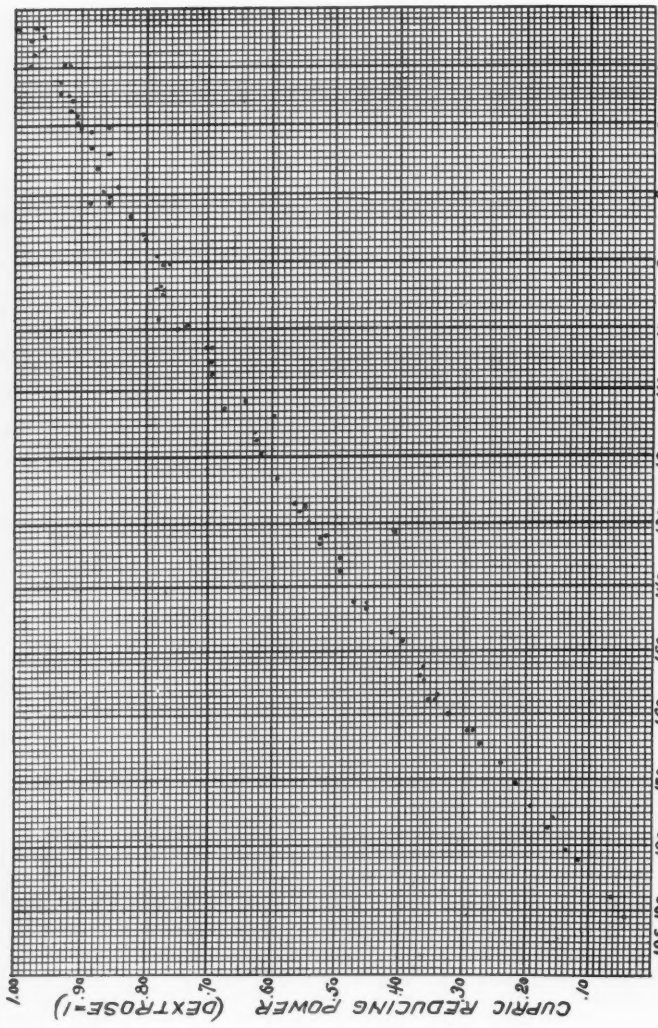

CUPRIC REDUCING POWER (DEXTROSE=1)
1.00
.90
.80
.70
.60
.50
.40
.30
.20
.10
DEGREES. [α]D386
180
170
160
150
140
130
120
110
100
90
80
70
60
50
RELATION OF K386 TO [α]D386

PLATE A.

The results point to the remarkable fact that the cupric reducing power of the total product bears a constant relation to the specific rotatory power, even when the starch is hydrolyzed under widely varying conditions. Hence, given the one, the value of the other can be calculated. To a rotation of about 90°, the plotted results outline with extraordinary exactness the arc of a circle, the equation of which is

$$x^2 + y^2 + 468x - 646y + 1580 = 0,$$

which exactly intercepts the "zero" and "hundred" points at 195 and 53.5, respectively. The upper part of the curve is not so well defined, the results showing more discrepancy at the high conversion stages. This may be due to some decomposition and the formation of "reversion" products as stated by Wohl,[1] Maercker, Ost, and others. Wohl's figures show the maximum amount of dextrose possible to be 92.7 per cent. of the theoretical quantity. Others give ninety-six to ninety-seven per cent., the missing dextrose being supposed to be converted into dextrin-like bodies identical with those variously described as "gallisin," "isomaltose," etc. We have experimented but little along this line, having made but one hydrolysis with this special object, using $\frac{N}{100}$ hydrochloric acid at four atmospheres pressure, with the following results:

Time of cooking.	$[\alpha]_D$.
60 minutes	55.24
90 "	53.09
120 "	53.40
150 "	54.42

While several of our own results at the low rotations show a cupric reducing power of only about ninety-six per cent. of that of pure dextrose, we do not think that we are justified in arriving at any definite conclusion with the data at hand.

That the solutions begin to color considerably at rotations beyond 90° is, moreover, a strong indication of such decomposition. On the other hand, this accounts for much of the discrepancy of the plot at this part of the curve, as it is exceedingly difficult to get accurate readings on the saccharimeter of these highly colored solutions. Obviously, too, slight errors in the

[1] *Ber. d. chem. Ges.*, **23**, 2101.

readings affect the calculations of the rotatory power the most at these lowest rotations.

Quite as noteworthy are the curves[1] plotted by taking the values of maltose, dextrin, and dextrose as computed for every

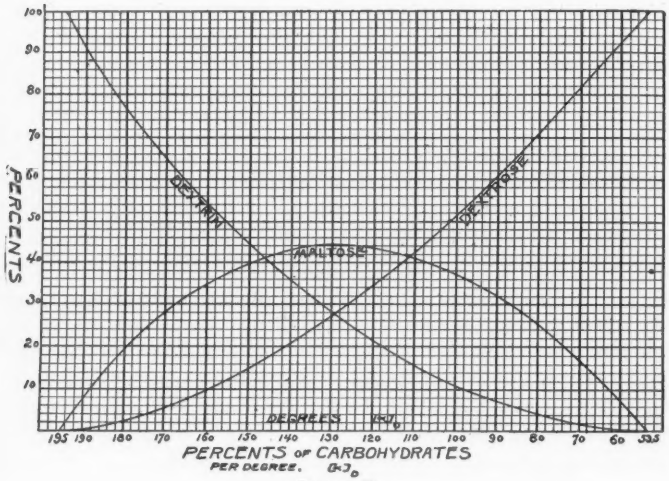


PLATE B.

five degrees of rotation from the values of K, as given by this curve.

In this work we have figured constants for solids estimated from the specific gravities of solutions by the factor, 386, and calculated percentages by the well-known equations:

$$g + m + d = 1.00$$
$$g + 0.61m = K$$
$$195d + 135.2m + 53.5g = \alpha$$

Where g is per cent. dextrose,
m is per cent. maltose,
and d is per cent. dextrin.

$$\text{Hence, } m = \frac{d + 141.5K - 195}{27.82}$$

[1] See plate B.

Examining these curves we see that the dextrin starting from the maximum of 100 per cent. gradually falls to zero near the rotation corresponding to dextrose, while the maltose gradually rises, reaches a maximum percentage of 44.1 at about 129° rotation, corresponding to the usual state of conversion of commercial glucose, and then falls, disappearing at 53.5°. The dextrose, on the contrary, steadily mounts to 100 per cent. It will be noted, too, that at the point of maximum maltose the dextrin and dextrose, as shown by the intersection of the curves, are present in equal quantity.

Tests with phenylhydrazin acetate show the presence of the dextrose distinctly at about 185°, and we had hoped to prove the gradual rise of the dextrose percentage by means of the dextrosazon. While copious precipitates of this beautiful compound were obtained, any attempt of ours to isolate it in anything like quantitative amounts proved a failure, even in solutions containing a known amount of pure dextrose. We hope to take this up more fully in a later investigation.

We have also calculated a table (Table C) from the curves giving the value of maltose, dextrose, and dextrin within one-tenth per cent. for successive stages of acid hydrolysis represented by each degree of rotation between 195 and 53.5. This table, calculated for the factor 386, makes no allowance for possible decomposition of high-converted products.

TABLE C.

CALCULATED VALUES OF CUPRIC REDUCING POWERS AND PARTS OF MALTOSE, DEXTROSE AND DEXTRIN PER UNIT OF CARBOHYDRATE FOR EACH DEGREE OF ROTATION OF A NORMALLY HYDROLYZED STARCH SOLUTION.

$[\alpha]_{D\ 386^\circ}^{20}$	K_{386°	M_{386°	g_{386°	d_{386°
195	0.000	0.000	0.000	1.000
194	0.011	0.017	0.001	0.982
193	0.022	0.033	0.001	0.966
192	0.032	0.048	0.002	0.950
191	0.041	0.063	0.002	0.935
190	0.051	0.079	0.003	0.918
189	0.061	0.094	0.004	0.902
188	0.071	0.110	0.005	0.885
187	0.081	0.123	0.007	0.870

$[\alpha]^{20}_{D\ 386^{\circ}}$	$K_{386^{\circ}}$	$M_{386^{\circ}}$	$g_{386^{\circ}}$	$d_{386^{\circ}}$
186	0.090	0.135	0.009	0.856
185	0.100	0.147	0.010	0.843
184	0.109	0.160	0.013	0.827
183	0.118	0.171	0.016	0.813
182	0.127	0.182	0.019	0.799
181	0.137	0.192	0.022	0.786
180	0.146	0.203	0.025	0.772
179	0.155	0.212	0.028	0.760
178	0.164	0.222	0.031	0.747
177	0.173	0.231	0.034	0.735
176	0.182	0.240	0.037	0.723
175	0.191	0.250	0.040	0.710
174	0.199	0.257	0.043	0.700
173	0.207	0.265	0.047	0.688
172	0.216	0.273	0.050	0.677
171	0.224	0.280	0.054	0.666
170	0.233	0.287	0.058	0.655
169	0.242	0.294	0.062	0.644
168	0.251	0.301	0.066	0.633
167	0.259	0.307	0.071	0.622
166	0.267	0.314	0.075	0.611
165	0.275	0.320	0.080	0.600
164	0.283	0.326	0.084	0.590
163	0.292	0.332	0.089	0.579
162	0.300	0.338	0.093	0.569
161	0.308	0.344	0.098	0.558
160	0.316	0.349	0.103	0.548
159	0.324	0.356	0.107	0.537
158	0.332	0.362	0.111	0.527
157	0.340	0.369	0.115	0.516
156	0.348	0.373	0.121	0.506
155	0.356	0.378	0.126	0.496
154	0.365	0.383	0.130	0.487
153	0.373	0.388	0.135	0.477
152	0.381	0.392	0.141	0.467
151	0.389	0.397	0.146	0.457
150	0.397	0.401	0.153	0.446
149	0.404	0.405	0.157	0.438
148	0.412	0.408	0.163	0.429
147	0.419	0.412	0.164	0.420
146	0.427	0.415	0.174	0.411
145	0.435	0.415	0.182	0.403
144	0.442	0.421	0.186	0.393
143	0.450	0.423	0.192	0.385

$[\alpha]^{20}_{D\,386}$.	K_{386}.	M_{386}.	g_{386}.	d_{386}.
142	0.458	0.425	0.199	0.376
141	0.465	0.427	0.205	0.368
140	0.473	0.428	0.212	0.360
139	0.481	0.431	0.217	0.352
138	0.488	0.432	0.224	0.344
137	0.496	0.434	0.231	0.335
136	0.503	0.436	0.237	0.327
135	0.510	0.437	0.243	0.320
134	0.517	0.438	0.249	0.313
133	0.524	0.439	0.256	0.305
132	0.531	0.439	0.263	0.298
131	0.538	0.440	0.270	0.290
130	0.546	0.440	0.277	0.283
129	0.553	0.441	0.284	0.275
128	0.560	0.441	0.291	0.268
127	0.567	0.440	0.298	0.262
126	0.574	0.440	0.305	0.255
125	0.580	0.439	0.313	0.248
124	0.588	0.438	0.320	0.242
123	0.595	0.438	0.327	0.235
122	0.602	0.437	0.335	0.228
121	0.608	0.436	0.343	0.221
120	0.614	0.435	0.350	0.215
119	0.621	0.433	0.358	0.209
118	0.628	0.431	0.366	0.203
117	0.635	0.429	0.374	0.197
116	0.642	0.428	0.381	0.191
115	0.649	0.425	0.390	0.185
114	0.656	0.422	0.398	0.180
113	0.663	0.420	0.408	0.174
112	0.669	0.417	0.414	0.169
111	0.675	0.414	0.423	0.164
110	0.681	0.408	0.432	0.160
109	0.687	0.407	0.439	0.154
108	0.694	0.403	0.448	0.149
107	0.700	0.400	0.456	0.144
106	0.707	0.396	0.465	0.139
105	0.713	0.392	0.474	0.134
104	0.719	0.387	0.483	0.130
103	0.725	0.383	0.492	0.125
102	0.732	0.379	0.500	0.121
101	0.738	0.375	0.508	0.117
100	0.744	0.370	0.518	0.112
99	0.750	0.366	0.527	0.107

$[\alpha]^{20}_{D\,386\cdot}$	$K_{386\cdot}$	$M_{386\cdot}$	$g_{386\cdot}$	$d_{386\cdot}$
98	0.757	0.361	0.537	0.102
97	0.763	0.356	0.546	0.098
96	0.769	0.350	0.556	0.094
95	0.775	0.345	0.565	0.090
94	0.781	0.341	0.574	0.085
93	0.787	0.336	0.583	0.081
92	0.793	0.331	0.592	0.077
91	0.799	0.326	0.601	0.073
90	0.805	0.320	0.610	0.070
89	0.810	0.314	0.620	0.066
88	0.816	0.308	0.629	0.063
87	0.822	0.302	0.638	0.060
86	0.828	0.295	0.649	0.056
85	0.834	0.288	0.658	0.054
84	0.839	0.282	0.667	0.051
83	0.844	0.275	0.677	0.048
82	0.850	0.267	0.688	0.045
81	0.856	0.259	0.698	0.043
80	0.862	0.251	0.709	0.040
79	0.867	0.243	0.719	0.038
78	0.872	0.234	0.730	0.036
77	0.878	0.225	0.741	0.034
76	0.884	0.217	0.751	0.032
75	0.889	0.208	0.762	0.030
74	0.895	0.200	0.772	0.028
73	0.901	0.191	0.783	0.026
72	0.906	0.182	0.794	0.024
71	0.911	0.173	0.805	0.022
70	0.916	0.163	0.817	0.020
69	0.921	0.153	0.828	0.019
68	0.926	0.143	0.839	0.018
67	0.932	0.134	0.850	0.016
66	0.937	0.125	0.861	0.014
65	0.942	0.115	0.872	0.013
64	0.947	0.105	0.883	0.012
63	0.952	0.095	0.895	0.010
62	0.957	0.085	0.906	0.009
61	0.962	0.075	0.917	0.008
60	0.967	0.065	0.927	0.008
59	0.972	0.055	0.938	0.007
58	0.977	0.045	0.949	0.006
57	0.982	0.035	0.960	0.005
56	0.987	0.025	0.971	0.004
55	0.992	0.015	0.982	0.003
54	0.997	0.005	0.993	0.002
53.5	1.000	0.000	1.000	0.000

It would seem obvious that we are now prepared to determine whether a sample of glucose is a product of one hydrolysis or is a mixture of two separately converted products, by comparison of the actual analytical results with those calculated from the rotatory power.

For testing this method we have made a few analyses of commercial glucoses obtained in open market.

In the manufacture of glucose syrup all the starch is not hydrolyzed under strictly the same conditions, as the factory practice is to pump the starch into the converter, which is under steam pressure and already contains the hydrolyzing acid. As the filling of a converter takes about one-third of the total time of cooking, it is clear that there is a radical difference in the time of hydrolysis of different portions of starch. Nevertheless, we have found that samples known to have been made under these conditions conform to the laws of our curve, and the evidence seems strong that those which depart widely from these conditions are mechanical mixtures.

The following determinations of four samples of commercial glucose giving the cupric reducing power as found and as calculated for the corresponding rotation will illustrate the method:

Sample.	α_{D386}.	K_{386} (obtained).	K_{386} (calculated).
I. C. Pope Co. (J).....	131.1	0.566	0.537
II. C. Pope Co. (M)....	125.4	0.578	0.578
III. Rockford Co	141.9	0.454	0.457
IV. Chicago Co.....	137.2	0.505	0.495

Evidently II and III are normally hydrolyzed. IV is possibly a mixture, while I is undoubtedly so. As this latter is a sample of jelly goods which in factory practice are often made by mixing two lots, our conclusion is strengthened.

From the results as a whole we have concluded that the evidence is strong, (1) that in any homogeneous acid-converted starch product, irrespective of the conditions of hydrolysis, the specific rotatory power always represents the same chemical composition.

(2) That but three simple carbohydrates,[1] possible in molecular aggregates, exist in the solution of a starch product hydrolyzed by acids.

[1] Leaving out of consideration the possible small amounts of products formed by reversion.

DETERMINATION OF THE CONVERSION OF COMMERCIAL GLUCOSE.

In the manufacture of glucose it is obviously essential to have a rapid means of determining the degree of conversion of the starch during the cooking process. The usual factory practice is to control the conversion by means of iodine color tests. These tests are usually made by adding a definite number of drops of standard iodine solution to a test-tube of the cooled glucose liquor. The tint at which the conversion is considered complete varies in general practice from that corresponding to $[\alpha]_D = 128$ to $[\alpha]_D = 135$, the variation being even greater in some cases, depending on the ideas of the manufacturer and the grade of goods desired.

By daily practice workmen become quite expert in making these iodine tints, which are usually carried out by crude methods and read off without comparison with any standard. Nevertheless, the product, when examined by more refined laboratory processes, shows wide variations from day to day, which does not appear surprising when we examine into the errors of such color tests.

Assuming that the test is carried out under uniform conditions of concentration and proportion of reagent to liquor to be tested, which is by no means always the case, the other conditions affecting the color are (1) temperature, (2) turbidity, and (3) illumination.

Uniform temperature can be obtained easily by some simple cooling device as a stream of running water.

The acid converter liquors are always turbid when tested, as filtration in this rapid testing is impracticable. The turbidity, however, is fairly constant. It is the third condition, that of illumination, which is constantly variable and which gives rise to the greatest error. This source of error can be largely eliminated by the use of a comparison standard, prepared of the same volume as that used in the color test and hermetically sealed in a glass tube of the standard size used in testing. Mixtures of solutions of iron salts with finely pulverized glass giving the requisite turbidity when shaken, can be easily made to exactly match the iodine tint, and will preserve their intensity indefi-

nitely. When properly adjusted by means of polariscopic tests such standards have served well to fix the point of conversion within narrow limits and have done much to insure a uniform product.

It is of course important that these should be in the hands of the chemist or superintendent of the works, a much more exact means of testing the degree of conversion. This is most naturally accomplished by determining the specific rotatory power.

We have arranged a table for quickly calculating specific rotatory power, and found it so useful that we venture to publish it. The following simple calculation will sufficiently explain the principles on which the table has been worked out:

TABLE D.

TABLE FOR DETERMINING SPECIFIC ROTATORY POWER OF SOLUTIONS OF 7.50°–10° BRIX BY READING OF VENTZKE SACCHARIMETER.

Brix.	Sp. gr.	W = gram per 100 cc.	Log $\frac{17.20}{W}$.	Brix.	Sp. gr.	W = gram per 100 cc.	Log $\left(\frac{17.20}{W}\right)$.
7.50	1.0298	7.724	0.3477	8.80	1.0352	9.110	0.2760
7.55	1.0300	7.777	0.3447	8.85	1.0354	9.163	0.2735
7.60	1.0302	7.829	0.3418	8.90	1.0356	9.217	0.2709
7.65	1.0304	7.883	0.3388	8.95	1.0358	9.270	0.2684
7.70	1.0306	7.936	0.3359	9.00	1.0360	9.324	0.2657
7.75	1.0308	7.989	0.3330	9.05	1.0362	9.378	0.2634
7.80	1.0310	8.042	0.3301	9.10	1.0364	9.430	0.2610
7.85	1.0312	8.096	0.3272	9.15	1.0366	9.484	0.2585
7.90	1.0315	8.149	0.3244	9.20	1.0368	9.538	0.2560
7.95	1.0317	8.202	0.3216	9.25	1.0370	9.592	0.2536
8.00	1.0319	8.255	0.3187	9.30	1.0372	9.646	0.2510
8.05	1.0321	8.308	0.3160	9.35	1.0374	9.690	0.2488
8.10	1.0323	8.361	0.3132	9.40	1.0376	9.753	0.2464
8.15	1.0325	0.415	0.3104	9.45	1.0378	9.807	0.2440
8.20	1.0327	8.468	0.3077	9.50	1.0381	9.862	0.2415
8.25	1.0329	8.522	0.3050	9.55	1.0383	9.916	0.2391
8.30	1.0331	8.575	0.3022	9.60	1.0385	9.970	0.2368
8.35	1.0333	8.629	0.2995	9.65	1.0387	10.023	0.2346
8.40	1.0335	8.682	0.2969	9.70	1.0389	10.077	0.2323
8.45	1.0337	8.735	0.2943	9.75	1.0391	10.130	0.2300
8.50	1.0339	8.788	0.2916	9.80	1.0393	10.185	0.2277
8.55	1.0341	8.842	0.2889	9.85	1.0395	10.239	0.2252
8.60	1.0343	8.895	0.2864	9.90	1.0397	10.293	0.2231
8.65	1.0345	8.949	0.2838	9.95	1.0399	10.347	0.2207
8.70	1.0347	9.002	0.2812	10.00	1.0401	10.401	0.2185
8.75	1.0350	9.056	0.2786				

Taking the usual formula for the specific rotatory power, $\alpha = \frac{av}{lw}$, where a is the angle of rotation of the solution of w

gram of the active substance in v cc. of water observed through a column l decimeters long. If we make $a = \alpha$ it is plain w is the weight of substance under standard conditions which will give a direct reading of the specific rotatory power without calculation. In an instrument reading in angular degrees under the usual conditions of $v = 100$ and $l = 2$, w is therefore $50\,g$.

If a is the reading of a saccharimeter with the Ventzke scale, $w = 50 \times 0.344 = 17.20$, and the specific rotatory power of any solution of known concentration of an optically active substance will be $\frac{17.2\,a}{w}$. The easiest way of finding the concentration of glucose solutions with sufficient exactness for this work is by the Brix (or Balling) hydrometer, as this instrument is now made of great accuracy.

Brix hydrometers are carried in regular stock of the larger houses dealing in chemical apparatus for brewers and sugar manufacturers, with scales having a range of about five degrees and easily read to 0.05 per cent. Thermometers are attached having corrections for temperature marked on the scale. Concentrations of about ten per cent. are most convenient for polarizing; hence a spindle will be needed reading from five to ten per cent.

The method of determining rotatory powers is as follows: The glucose is diluted to an approximately ten per cent. solution. An exact Brix (or Balling) reading is taken, corrected for standard temperature and the solution polarized in a 200 mm. tube in any saccharimeter with the Ventzke scale. The logarithm of the factor $\frac{17.20}{w}$ corresponding to the Brix reading is then found in the table. Therefore, the calculation which is, $\log\ [\alpha]_D = \log\ \left(\frac{17.20}{w}\right) + \log\ a$, simply requires finding the logarithm of the saccharimeter reading and the number corresponding to the sum of this and the logarithm given in the table. This number is the required specific rotatory power.[1]

[1] Obviously a table made on the scheme of the well-known Schmitz table for cane-sugar syrups would do away with all calculation. Such a table is, however, rather bulky for insertion here.

Thus a solution of 7.85 Brix having a reading of 51.7°, Ventzke has the rotatory power of its anhydrous carbohydrates determined as follows:

By the table, the corresponding logarithmic factor is 0.3272.

$$\begin{aligned} \text{Log } 51.7 &= 1.7135 \\ \text{Factor} \quad & \quad 0.3272 \\ \hline & 2.0407 = \log 109.8 \end{aligned}$$

which is the required rotatory power.

In this calculation no correction is made for ash, which, as a rule, does not affect the results appreciably.

The errors due to the slight variations in the concentration of the solutions used and changes in the temperature of the laboratory are too small to be taken into consideration in factory work or in general commercial analysis. The method in practice is quite as rapid as the "quotient of purity" determination of cane-sugar syrups. We suggest that this, or some similar scheme, be uniformly used for expressing the results of all polarimetric investigations of honeys, syrups, and similar indeterminate mixtures of carbohydrates met with in commercial analysis, instead of merely giving the polarizations, or the specific rotatory powers referred to the weights of the sample. The advantages are obvious. Such analytical results would be close approximations to the exact specific rotatory powers of the mixed anhydrous carbohydrates, and would be convenient of interpretation by inspection as being directly comparable on what is for all practical purposes an absolute standard and the one used in all strictly scientific work of the kind.

THE SPEED OF THE HYDROLYSIS OF STARCH BY ACIDS.[1]

The laws of the speed of hydrolysis of the carbohydrates with the exception of that of cane-sugar have been but little studied. Solomon[2] has collected some data on the action of various acids at boiling temperature. Welhelmy[3] showed in the case of the catalytic action of hydrochloric acid on cane-sugar that if the

[1] We are greatly indebted to Prof. A. A. Noyes, of this department, for valuable aid in calculating the results of this work on speed of hydrolysis.

[2] *J. prakt. Chem.*, (2), 28.

[3] *Ber. d. chem. Ges.*, **18**, 2211.

amount of acid and the temperature remained constant the rate of the inversion at any specified moment is proportional to the amount of unchanged sugar present at that moment.

That is, if A_o represent the amount of sugar originally present, x the amount of this sugar changed over in any period of time, t, and c the reaction-constant, we have $\frac{dx}{dt} = c\,(A_o - x)$.

The relative values of the constant, c, of the various acids in their action on cane-sugar have been determined by several observers, notably Ostwald,[1] who has compared, by means of their constants, the relative effect of chemically equivalent quantities of a large number of acids, taking the constant of hydrochloric acid as a standard with the arbitrary value of 100.

Recent work shows that acids act on salicin,[2] one of the glucosides, in a manner analogous to that of cane-sugar, the speed of hydrolysis of this body by the different acids bearing the same relation to hydrochloric acid.

The observations noted above suggested the possibility that in the hydrolysis of starch the acids would show the same proportional speed of reaction. This is an especially interesting problem because the starch molecule is exceedingly complicated, the molecular weight being undoubtedly very high. Starch hydrolysis, however, must be considered as somewhat different from that of cane-sugar or salicin. While these are easily soluble in cold water, starch is totally insoluble at ordinary room temperature. On the other hand, amylodextrin, the product of decomposition of starch by boiling water, is somewhat soluble in cold water, its solubility increasing with rise of temperature.

As by the customary procedure in determining speed of hydrolysis, it would be necessary to ascertain the exact moment when all the starch has been converted into the soluble form, a point not conveniently determined, we have adopted a method of measurement, based on the following principles:

The conversion products of starch, with the possible exception of those of very high rotatory power, are easily soluble in water, and can be looked upon as mixtures of maltose, dextrose and dextrin.

[1] *J. prakt. Chem.*, *1884*, 401.

[2] Noyes and Hall: *Ztschr. phys. Chem.*, *1895*, 240.

The starch first changes to amylodextrin. The hydrolysis then proceeds by successive stages through the so-called maltodextrin, maltose, and dextrose. "Reversion," so-called, may take place to some extent, a small amount of the dextrose forming dextrin-like bodies, "gallisin," "isomaltose," etc., but this point is not considered in this work. The dextrin may therefore be looked upon as the original substance hydrolyzed, and maltose and dextrose as successive products of the reaction.

Further, we have shown that whatever the condition of hydrolysis by acids, the specific rotatory power of any conversion product corresponds to a definite chemical composition, tables for determining which we have constructed.

Thus, for instance, a conversion product of 160° has been proved to contain 54.8 per cent. dextrin, the remainder being maltose and dextrose.

Hence, the time of taking any sample after the contents of the autoclave has acquired constant temperature, which requires about ten minutes, can be taken as the initial point for determining speed of hydrolysis, and all subsequent samples referred to this, as it is obvious that in any sample we can ascertain the dextrin unacted upon at that stage of the hydrolysis. The same holds true of maltose.

We have to deal with two reactions, the first being the hydrolysis of dextrin to maltose.

If A_o is the amount of dextrin at the initial point taken, $A_o - x$, the amount remaining at any time, t, and c the constant depending on conditions of hydrolysis we get, $\frac{dx}{dt} = c\,(A_o - x)$.

This, on integrating, gives $\log \frac{A_o}{A - x} = ct$, or $\frac{1}{t} \log \frac{A_o}{A_o - x} = c$, which is the general equation of a first-order reaction. The second decomposition is that in which maltose is hydrolyzed to dextrose, and is peculiar in so far as it proceeds simultaneously with that by which the maltose is formed. As a result of the hydrolysis of the dextrin the maltose increases rapidly to a maximum of 44.1 per cent. at a rotation of 129°.

It then gradually diminishes, while the dextrose percentage always increases.

Consequently, the equation expressing accurately the rate of change in the total amount of maltose present is quite complicated, and we have therefore used an approximate formula, which is sufficiently exact for the work in hand. The formula is derived from the exact differential equation

$$\frac{dD}{dt} = c_2 M,$$

which states that the amount of dextrose formed at each moment is proportional to the amount of maltose present by replacing the differential quantities by finite differences, which in applications of the formula must of course be taken small. In the place of M the average amount of maltose present during the interval of time considered is also substituted. That is, if M_1 and M_2 are the amounts of maltose present at the time, t_1 and t_2, and D_1 and D_2 the amounts of dextrose present at these same times, and c_2 is the reaction constant, we get as a result of the above mentioned substitutions :

$$D_2 - D_1 = c_2 \frac{M_1 + M_2}{2} (t_2 - t_1),$$

or,

$$\left(\frac{1}{t_2 - t_1}\right)\left(\frac{D_2 - D_1}{\frac{M_1 + M_2}{2}}\right) = c_2.$$

The results are contained in the following tables :

TABLE E.

SPEED OF HYDROLYSIS OF STARCH.

Time t. (minutes)	$[\alpha]^{20}_{D\ 386}$.	$A_0 - x$.	$\log \frac{A_0}{A_0 - x}$	C_1.	$\frac{D_2 - D_1}{\frac{m_1 + m_2}{2}}$	C_2.
Hydrochloric acid : 0.02 normal ; at 2 A $T = 135°$ C.						
$t_0 = 20$; $[\alpha]^{20}_{D\ 386} = 161$; $A_0 = 55.8$.						
10	137	35.5	0.2216	0.02216	0.3581	0.0358
20	118	20.3	0.4391	0.02196	0.3118	0.0312
30	100	11.2	0.6784	0.02261	0.3790	0.0379
40	88	6.3	0.9684	0.02421	0.3274	0.0327
50	76	3.2	1.2415	0.02483	0.4638	0.0464
60	69	1.9	1.4678	0.02446	0.4162	0.0416
70	64	1.2	1.6674	0.02382	0.4264	0.0426
	$C_1 = 0.02344$.				$C_2 = 0.0373$.	

Sulphuric acid : 0.02 normal ; at 2 A $T = 135°$ C.

$t_0 = 20$; $[\alpha]^{20}_{D\ 386} = 177°$; $A_0 = 73.5$.

10	163	57.9	0.1036	0.01036	0.1954	0.0195
20	152	46.7	0.2248	0.01124	0.1436	0.0144
30	140	36.0	0.3100	0.01033	0.1703	0.0170
40	129	27.5	0.4270	0.01068	0.1678	0.0168
60	109	15.4	0.6788	0.01131	0.3656	0.0188
80	90	7.0	1.0212	0.01277	0.4700	0.0235
100	77	3.4	1.3348	0.01335	0.4809	0.0240
120	66	1.4	1.7202	0.01434	0.6915	0.0346
	$C_1 = 0.0118$.				$C_2 = 0.0211$.	

Oxalic acid : 0.04 normal ; at 2 A $T = 135°$ C.

$t_0 = 20$; $[\alpha]^{20}_{D\ 386} = 180°$; $A_0 = 77.2$.

20	157	51.6	0.1750	0.00875	0.3147	0.0157
40	137	33.5	0.3626	0.00907	0.2890	0.0145
60	120	21.5	0.5552	0.00925	0.2738	0.0137
80	106	13.9	0.7446	0.00931	0.2762	0.0138
100	93	8.1	0.9791	0.00979	0.3224	0.0161
120	82	4.5	1.2344	0.00029	0.3426	0.0171
140	73	2.6	1.4726	0.01052	0.4149	0.0207
	$C_1 = 0.00957$.				$C_2 = 0.0159$.	

Sulphurous acid : 0.02 normal ; at 2 A $T = 135°$ C.

$t_0 = 50$; $[\alpha]^{20}_{D\ 386} = 187°$; $A_0 = 87$.

50	179	76.0	0.0587	0.00117	0.1254	0.00251
100	172	67.7	0.1089	0.00109	0.0907	0.00181
150	165	60.0	0.1613	0.00108	0.1012	0.00202
200	159	53.7	0.2095	0.00105	0.0799	0.00159
250	151	45.7	0.2796	0.00112	0.1036	0.00207
300	144	39.3	0.3451	0.00115	0.0978	0.00196
350	137	33.5	0.4145	0.00119	0.1053	0.00211
400	131	29.0	0.4773	0.00119	0.0893	0.00179
	$C_1 = 0.00113$.				$C_2 = 0.00198$.	

Acetic acid : 0.5 normal ; at 2 A $T = 135°$ C.

$t_0 = 50$; $[\alpha]^{20}_{D\ 386} = 170°$; $A_0 = 65.5$.

50	143	38.5	0.2307	0.00461	0.3775	0.00755
100	121	22.1	0.4718	0.00472	0.3516	0.00703
150	103	12.5	0.7193	0.00480	0.3643	0.00729
200	86	5.6	1.0680	0.00534	0.4638	0.00928
250	74	2.8	1.3690	0.00548	0.4969	0.00994
	$C_1 = 0.00449$.				$C_2 = 0.00822$.	

Hydrochloric acid : 0.01 normal ; at 1 A $T = 121°$ C.

$t_0 = 40$; $[\alpha]^{20}_{D\ 386} = 183°$; $A_0 = 81.3$.

40	168	63.3	0.1087	0.00272	0.2118	0.00529
70	158	52.7	0.1883	0.00269	0.1358	0.00453
100	149	43.8	0.2686	0.00269	0.1199	0.00400
140	137	33.5	0.3851	0.00275	0.1764	0.00441
180	126	25.5	0.5036	0.00280	0.1693	0.00423
200	120	21.5	0.5777	0.00289	0.1028	0.00514
250	107	14.4	0.7517	0.00301	0.2539	0.00508
	$C_1 = 0.00279$.				$C_2 = 0.00467$.	

Hydrochloric acid : 0.01 normal ; at 2 A $T = 135°$ C.

$t_0 = 20$; $[\alpha]^{20}_{D\ 386} = 176°$; $A_0 = 72.3$.

10	162	56.9	0.1040	0.0104	0.1937	0.0194
20	148	42.9	0.2266	0.0113	0.1877	0.0188
40	128	26.8	0.4310	0.0108	0.3015	0.0151
60	110	16.0	0.6550	0.0109	0.3259	0.0163
80	93	8.1	0.9506	0.0119	0.4102	0.0205
100	81	4.3	1.2256	0.0123	0.3830	0.0182
120	70	2.0	1.5581	0.0130	0.4479	0.0294
	$C_1 = 0.0115$.				$C_2 = 0.0187$.	

Hydrochloric acid : 0.01 normal ; at 3 A $T = 145°$ C.

$t_0 = 10$; $[\alpha]^{20}_{D\ 386} = 174°$; $A_0 = 70$.

5	158	52.7	0.1233	0.0247	0.2766	0.0553
10	140	36.0	0.2888	0.0289	0.2528	0.0506
15	125	24.8	0.4506	0.0300	0.2351	0.0470
20	110	16.0	0.6410	0.0321	0.2756	0.0551
30	88	6.3	1.0458	0.0349	0.5544	0.0554
40	74	2.8	1.3979	0.0350	0.5630	0.0563
50	65	1.3	1.7212	0.0344	0.6349	0.0640
	$C_1 = 0.0314$.				$C_2 = 0.00548$.	

Hydrochloric acid : 0.01 normal ; at 4 A $T = 153°$ C.

$t_0 = 10$; $[\alpha]^{20}_{D\ 386} = 147°$; $A_0 = 42.0$.

5	117	19.7	0.3287	0.0657	0.4900	0.0980
10	96	9.4	0.6501	0.0650	0.4671	0.0934
15	79	3.8	1.0434	0.0696	0.5443	0.1088
20	68	1.8	1.3679	0.0684	0.6060	0.1212
25	61	0.85	1.6938	0.0678	0.7157	0.1431
30	57	0.5	1.9242	0.0641	0.7818	0.1564
	$C_1 = 0.0668$.				$C_2 = 0.1202$.	

Hydrochloric acid : 0.04 normal ; at 3 A $T = 145°$ C.

$t_0 = 5$; $[\alpha]^{20}_{D\ 386} = 150°$; $A_0 = 44.7_1$

3	115	18.5	0.3831	0.1277	0.5736	0.1912
5	95	9.0	0.6961	0.1392	0.4541	0.2270
7	80	4.0	1.0481	0.1497	0.4833	0.2416
10	66	1.4	1.5042	0.1504	0.8083	0.2694
13	58	0.6	1.8721	0.1440	1.0350	0.3450
15	66	0.4	2.0482	0.1365	0.6285	0.3143
	$C_1 = 0.1413$.				$C_2 = 0.2648$.	

Hydrochloric acid : 0.02 normal ; at 3 A $T = 145°$ C.

$t_0 = 10$; $[\alpha]^{20}_{D\ 386} = 148°$; $A_0 = 42.9$.

5	116	19.1	0.3515	0.0703	0.5246	0.1049
10	96	9.4	0.6594	0.0659	0.4478	0.0896
15	80	4.0	1.0304	0.0687	0.5075	0.1015
20	69	1.9	1.3537	0.0677	0.5889	0.1178
25	61	0.85	1.7031	0.0681	0.7739	0.1548
30	56	0.45	1.9793	0.0660	1.0800	0.2160
	$C_1 = 0.0678$.				$C_2 = 0.1304$.	

Hydrochloric acid : 0.01 normal ; at 3 *A* $T = 145°$ C.

$t_0 = 5$; $[\alpha]^{20}_{D\ 386} = 174°$; $A_0 = 70$.

5	158	52.7	0.1233	0.0247	0.2766	0.0553
10	140	36.0	0.2888	0.0289	0.2528	0.0506
15	125	24.8	0.4506	0.0300	0.2351	0.0470
20	110	16.0	0.6410	0.0321	0.2756	0.0551
30	88	6.3	1.0458	0.0349	0.5544	0.0554
40	74	2.8	1.3974	0.0350	0.5630	0.0563
50	65	1.3	1.7212	0.0344	0.6349	0.0640
	$C_1 = 0.0314$.				$C_2 = 0.0548$.	

Hydrochloric acid : 0.005 normal ; at 3 *A* $T = 145°$ C.

$t_0 = 20$; $[\alpha]^{20}_{D\ 386} = 172°$; $A_0 = 67.7$.

20	142	37.6	0.2554	0.0128	0.4270	0.0214
40	113	17.4	0.5901	0.0148	0.4900	0.0245
60	91	7.3	0.9673	0.0161	0.5226	0.0261
80	77	3.4	1.2991	0.0162	0.5082	0.0254
100	66	1.4	1.6845	0.0168	0.7429	0.0371
120	59	0.7	1.9855	0.0165	0.8172	0.0409
	$C_1 = 0.0155$.				$C_2 = 0.0279$.	

At the head of each table are given data as to the concentration and nature of the acid, the temperature corresponding to the steam pressure given in atmospheres and $[\alpha]^{20}_{D\ 386}$ at the initial time period t_0 with the corresponding value of A_0. Time values are expressed in minutes, and the constants c_1 for the hydrolysis of dextrin, c_2 for that of maltose, are calculated according to the formulas given above.

The results show that the constants in general are satisfactory, and that therefore the reaction like the sucrose inversion follows the law of the first order. It will also be seen that the values c_1 are much more uniform than those of c_2, which is to be expected since c_1 is absolute and c_2 only approximate. Deviations of c_1 may be fairly ascribed to variations in temperature which, though slight, are significant, owing to the high temperature coefficient of the reaction.

The dextrin values in Table C are consequently correct within the limits of error of analysis. It will be seen that the values of c_2 are much more constant in those determinations in which t is larger and the values of $[\alpha]_D$ decrease slowly. This was to be expected from the conditions of the approximate formula given above for the decomposition of maltose, these requiring that the amount of substance changed in a period of time must be small. The question of reversion may possibly have some

influence on the values of c_s but as yet we are not prepared to express ourselves definitely on this subject.

The relative effects are shown in the following table: Table I shows the influence on the speed of hydrolysis of various acids at the same temperature, 135° C.

Table II shows the influence of temperature on the speed of hydrolysis when the same amount of acid is used.

Table III gives the influence of varying amounts of acid.

The mean value of constants are given in column II. Column III gives the relative value of the constants referred to that of $\frac{1}{100}N$ hydrochloric acid at 135° taken as 100. Column IV gives the velocity constants determined by Ostwald[1] for cane-sugar inversion by the same acids at half-normal concentration.

TABLE I.

Acid.	Concentration.	II.	III.	IV.
Hydrochloric	0.02 N	0.02344	100	100
Sulphuric.....	0.02 N	0.0118	50.35	53.6
Oxalic	0.04 N	0.00957	40.83	....
(").....	(0.02 N)	(0.00479)	(20.42)	18.6
Sulphurous.....	0.02 N	0.00113	4.82	....
Acetic	0.5 N	0.00499	21.29	....
(").....	(0.02 N)	0.00020	0.8	0.4

TABLE II.

Acid.	Concentration.	Temp.	I.	II.
Hydrochloric.....	0.01 N	121	0.00279	11.91
"	0.01 N	134	0.0115	49.07
"	0.01 N	145	0.0314	13.40
"	0.01 N	153	0.0668	28.50

TABLE III.

Acid.	Concentration.	II.	III.
Hydrochloric.....	0.04 N	0.1413	602.9
"	0.02 N	0.0678	289.3
"	0.01 N	0.0314	134.0
"	0.005 N	0.0155	66.13

It is seen that the corresponding numbers of columns III and IV agree fairly well. The relative influence of the various acids upon the hydrolysis of starch, sucrose and salicin are therefore nearly identical. It should be noted however that the chemical activity of hydrochloric acid on starch, as in the case of salicin

[1] *Loc. cit.*

and cane-sugar, increases in a greater ratio than the concentration, while the electrical conductivity increases more slowly.

The influence of temperature can be explained graphically by a curve approximating a parabola.

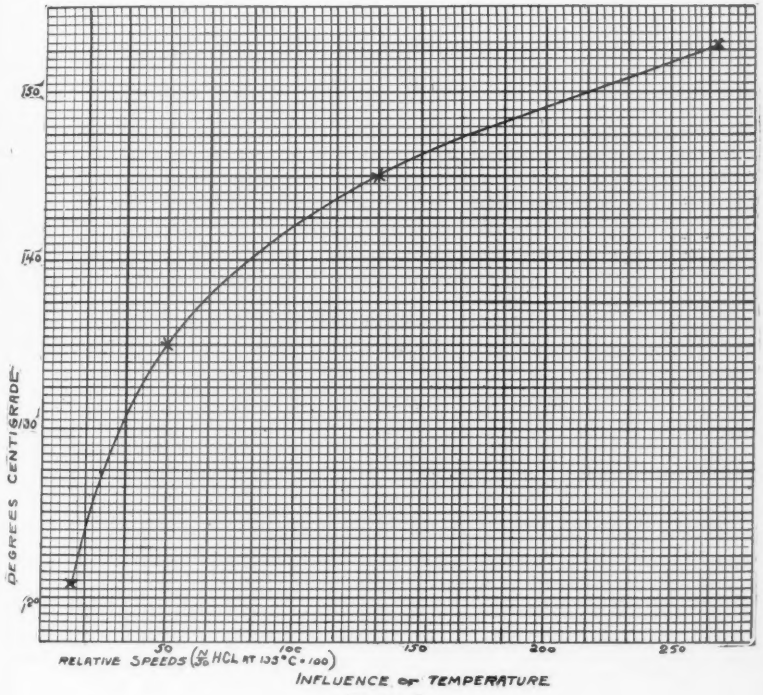


PLATE I.

Plate II shows the influence of the various acids.

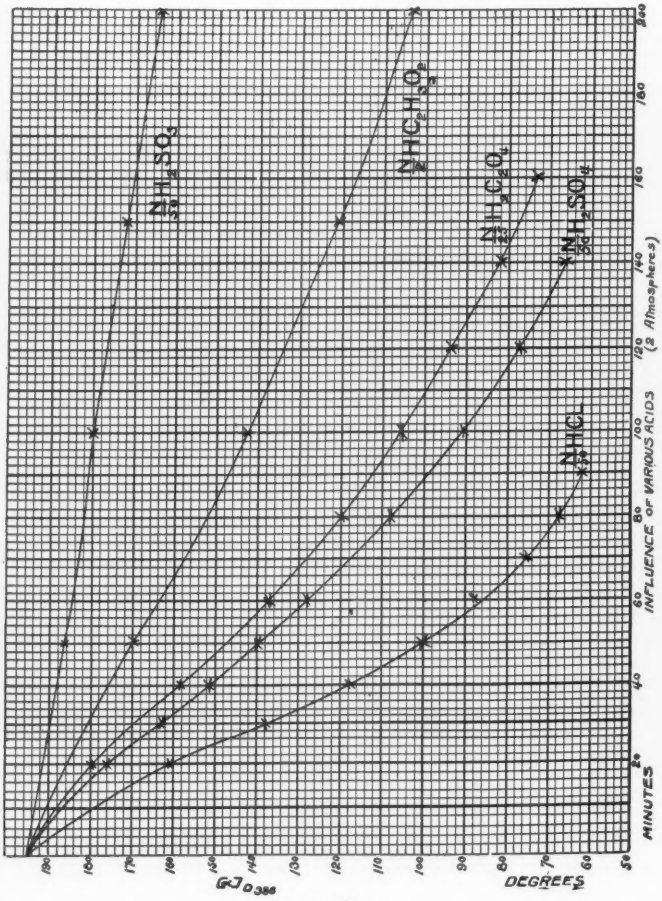


PLATE II.

Plate III shows the influence of the concentration, or amount of acid used.

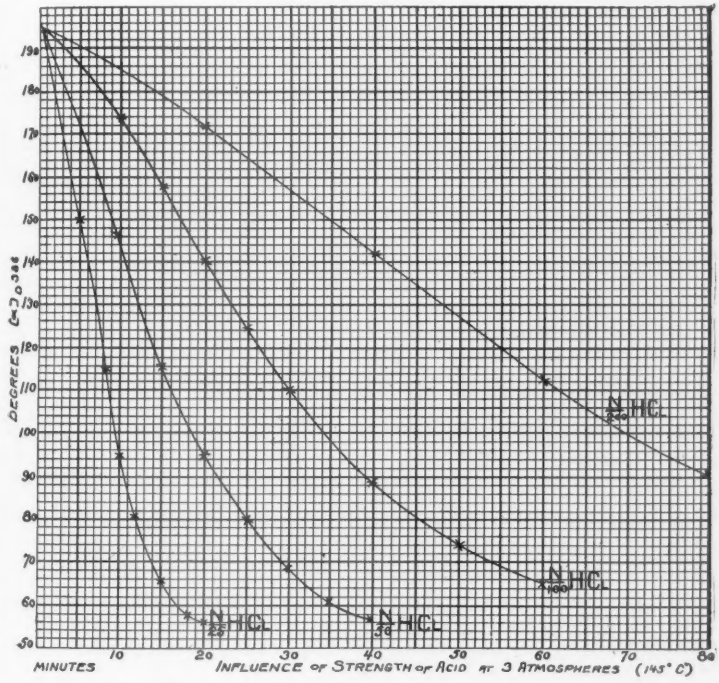


PLATE III.

Plate IV shows the relative curves due to temperature.

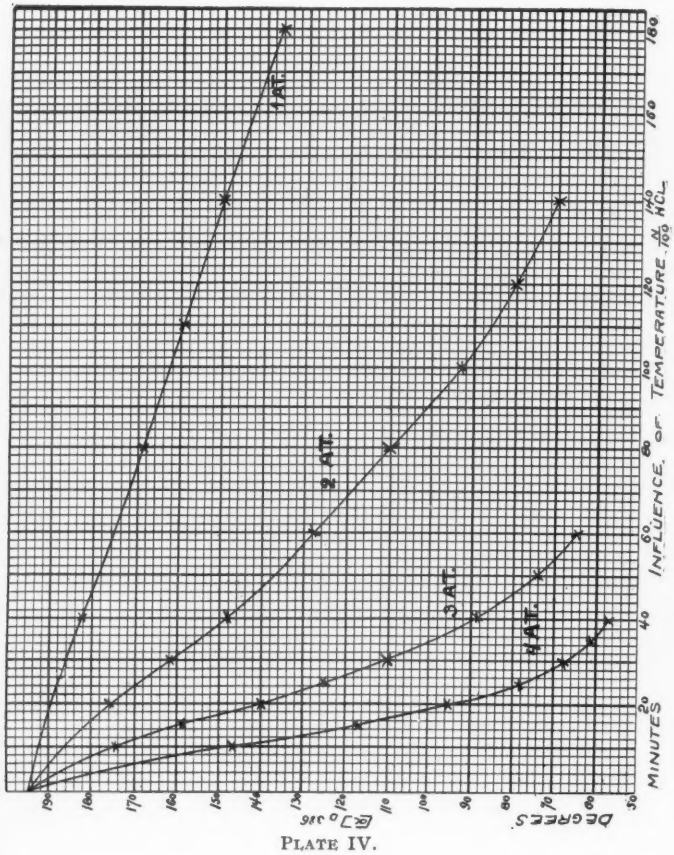


PLATE IV.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY,
BOSTON, MASS.

NICKELO-NICKELIC HYDRATE, $Ni_3O_4.2H_2O$.

By William L. Dudley.

Received August 26, 1896.

IN studying the action of fused sodium dioxide on metals, I have obtained interesting crystalline compounds, some of which, at least, have never been described. Only one of them has been carefully investigated and it proves to be nickelo-nickelic hydrate, having the formula $Ni_3O_4.2H_2O$.

It is prepared by fusing sodium dioxide in a nickel crucible with metallic nickel at a cherry-red heat. The action of the oxide upon the nickel proceeds with moderate rapidity, and in a few minutes scaly crystals appear floating in the fused mass. The crystals multiply steadily until, in the course of an hour, the contents of the crucible is thick with them, and comparatively little liquid remains. After cooling, the crucible is submerged in a beaker of distilled water and the undecomposed sodium dioxide together with the sodium oxide dissolves out, leaving the crystals which rapidly settle to the bottom of the liquid. The crystals should be washed several times with boiling water by decantation, and finally thrown in a filter. It is quite difficult to wash out all of the alkali, which adheres with unusual persistence. Probably the best plan to adopt is to put the crystals in a Soxhlet extraction apparatus and wash with water until no coloration is obtained with phenolphthalein. This requires about fifty hours of continuous washing. The crystals should then be dried at 110° C. and a magnet passed carefully through them to remove any particles of metallic nickel which may have eroded and not been completely acted upon.

The crystals are lustrous and almost black, with a slight brown-bronze hue. They are soft, and grind in a mortar much like graphite. The crystals seem to be hexagonal plates, but measurements of the angles have not been made. They dissolve slowly in acids, forming nickelous salts. Hydrochloric acid evolves chlorine; sulphuric and nitric acids, oxygen. They are insoluble in water and in solutions of the alkalies. The compound is not magnetic. The specific gravity is 3.4115 at 32° C.

At 130° C. the compound does not undergo decomposition, but at about 140° C. it begins to lose weight; at 240° C. the weight

remains constant. At a red heat further loss is sustained and the residue remaining is nickelous oxide. The loss from 130° C. to 240° C. is due to water driven off, and at a red heat this loss is due to the evolution of oxygen.

The compound proved to be $Ni_3O_4.2H_2O$, as is shown by the results of the analysis:

Loss of H_2O on heating from 130° C. to 240° C.:

	Per cent.
First determination	13.00
Second "	13.13
Theory for $Ni_3O_4.2H_2O$	13.06

The residue remaining after heating to 240° C. is Ni_3O_4. On heating this residue to redness the loss of oxygen was found to be:

	Per cent.
Loss of oxygen	6.63
Theory	6.67

The total loss of water and oxygen obtained on heating the compound from 130° C. to redness was:

	Per cent.
First determination	18.91
Second "	18.88
Theory for $Ni_3O_4.2H_2O$	18.86

The oxygen given off on heating to redness was determined by calcining the compound in an atmosphere of carbon dioxide and collecting in Schiff's apparatus over potassium hydroxide solution. The result gave:

	Per cent.
Oxygen	5.93
Theory for $Ni_3O_4.2H_2O$	5.84

The nickel was determined and found to be:

	Per cent.
Nickel	63.67
Theory	63.72

In all of the calculations the atomic weight of nickel was taken to be 58.56 and oxygen 16.

The compound made in a nickel crucible of commerce is not perfectly pure, as the sample obtained was found to contain 0.71 per cent. of cobalt, the presence of which, however, would make no appreciable difference in the results of the analyses. No method has been found for freeing the compound from this im-

purity, and it appears at present as if the only plan would be to use a chemically pure nickel crucible in making it, for no crucible will withstand the action of fused sodium dioxide. Porcelain, iron, silver, gold and platinum crucibles are rapidly attacked.

The presence of water in this compound seems curious, but it may be due to the presence of sodium hydroxide in the sodium dioxide. Again it may be due to the water added to dissolve the soluble residue from the crystals. The first explanation seems to be the more plausible since the crystals are formed in the mass while it is fused, and they are not produced upon the addition of the water. If such is the case it would seem that the water driven off between 130° C. and 240° C. is from the breaking down of a true hydrate, rather than the expulsion of water of crystallization.

A cobalto-cobaltic hydrate, $Co_3O_4.2H_2O$, has been described,[1] but it was obtained by exposing to moist air, Co_3O_4, prepared by heating cobalt carbonate. Ni_3O_4, prepared by heating nickelo-nickelic hydrate to 240° C. is hygroscopic and absorbs about seven and four-tenths per cent. of water from the air at 30° C., which is completely lost at 110° C., showing that no hydrate is formed under these conditions.

The study of the action of fused sodium dioxide on the metals will be continued here, and it is hoped that some more data can be contributed soon.

VANDERBILT UNIVERSITY.

TABLE OF FACTORS.

BY EDMUND H. MILLER AND J. A. MATHEWS.

Received August 6, 1896.

ATOMIC masses, based on O = 16, taken from an article by F. W. Clarke, this Journal, March, 1896.

	Required.	Factor.	Logarithm.
$AlPO_4$	Al.	0.221976	1.3463071
	Al_2O_3.	0.418489	1.6216835
Sb_2O_4	Sb.	0.790067	1.8976643
Sb_2S_3	Sb.	0.714570	$\bar{1}$.8540446
As_2S_3	As.	0.609522	$\bar{1}$.7849890
$Mg_2As_2O_7$	As.	0.483268	$\bar{1}$.6841870
Ag_3AsO_4	As.	0.162234	1.2101418
$BaSO_4$	BaO.	0.657088	$\bar{1}$.8176234

[1] Genth and Gibbs: *Am. J. Sci.*, **23**, 257.

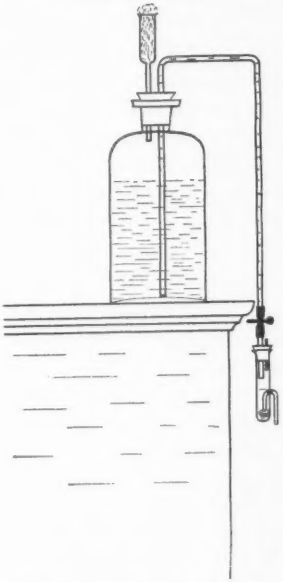
	Required.	Factor.	Logarithm.
	SO_3.	0.342912	1.5351829
	S.	0.137342	1.137812
Bi_2O_3	Bi.	0.896600	1.9525990
$CaCO_3$	CaO.	0.560296	1.7484173
$CaSO_4$	CaO.	0.411899	1.6147904
	$CaCO_3$.	0.735145	1.8663731
CO_2	C.	0.272893	1.4359916
Cr_2O_3	Cr.	0.684791	1.8355581
$3K_2SO_4.2CoSO_4$	Co.	0.141511	1.1507892
CuO	Cu.	0.798995	1.9025440
Cu_2S	Cu.	0.798644	1.9023531
Fe_2O_3	Fe.	0.700076	1.8451446
Fe	Fe_2O_3.	1.42842	0.1548554
	FeO.	1.28561	0.1091100
	Fe_3O_4.	1.38082	0.1401359
$PbCrO_4$	Pb.	.640500	1.8065193
$PbSO_4$	Pb.	.682927	1.8343742
$Mg_2P_2O_7$	P.	.278681	1.4451076
	P_2O_5.	.638038	1.8048465
	MgO.	.361962	1.5586631
	$MgCO_3$.	.757343	1.8792934
Mn_3O_4	Mn.	.720490	1.8576283
$Mn_2P_2O_7$	Mn.	.387226	1.5879648
$(NH_4)_2PtCl_6$	Pt.	.439205	1.6426669
	N.	.063281	2.8012744
	NH_3.	.076911	2.8859881
	NH_4Cl.	.241235	1.3824396
Pt from $(NH_4)_2PtCl_6$	N.	.144081	1.1586075
	NH_3.	.175114	1.2433212
	NH_3Cl.	.549253	1.7397727
K_2PtCl_6	KCl.	.306951	1.4870695
	K_2O.	.193944	1.2876767
KCl	K_2O.	.631840	1.8006072
K_2SO_4	K_2O.	.540593	1.7328706
SiO_2	Si.	.470199	1.6722814
AgBr	Br.	.425560	1.6289611
AgI	I.	.540313	1.7326479
AgCl	Cl.	.247262	1.3931579
	Ag.	.752738	1.8766436
NaCl	Na_2O.	.530769	1.7249057
Na_2SO_4	Na_2O.	.436801	1.6402836
SnO_2	Sn.	.788150	1.8966087
TiO_2	Ti.	.600749	1.7786928
ZnO	Zn.	.803464	1.9049663
$Zn_2P_2O_7$	Zn.	.429115	1.6325737
$ZnNH_4PO_4$	Zn.	.366438	1.5640011

RAPID MEASURING PIPETTE.

By Edward L. Smith.

Received August 4, 1896.

THE apparatus described below is a device for rapidly measuring and discharging a definite volume of liquid. It may be well to state at this point that the principle is not applicable in all, or in even the majority of cases, where it is desired to measure and discharge liquid reagents in the laboratory. Where extreme accuracy is essential, the ordinary pipette or a burette must still be used. Perhaps the best way to explain the utility of the apparatus will be to state the exact use to which it is put in our laboratory. In the course of some experiments with sand filters, samples of the different effluents as well as of the applied sewage were taken daily, treated with a small quantity of a concentrated sterilizing agent, and an analysis made each week of the combined daily samples.



It was to measure and discharge this sterilizing solution that the apparatus was devised. The quantity added in each case was five cc. Of course a variation from that amount of one- or two-tenths cc. would not materially affect the results and the great advantage in convenience and rapidity over the use of the common pipette for the same purpose is admitted by all who have seen the apparatus work. A large bottle forms the reservoir. The stopper of this bottle carries two tubes. One simply serves to admit air and contains a loose plug of cotton to exclude dust, etc. The other tube is bent to form an ordinary siphon and the end of the longer limb is attached to a short glass tube by means of a rubber connection,

provided with a pinch-cock. The short glass tube to which reference was just made passes through a stopper inserted into the mouth of an ordinary test-tube. Through a hole blown in the side of this tube another glass tube, bent to form a siphon, is inserted and fastened in place by a piece of rubber tubing of the proper size, slipped on over the tube. The leg of the siphon inside the test-tube is of such a length that when the pinch-cock above is opened and the liquid allowed to enter the test-tube, five cc. will be automatically discharged when the level of the liquid has reached a mark on a line with the top of the bend in the siphon tube.

The apparatus can be constructed in a few moments in any laboratory, and for purposes to which it is adapted, it will, I am sure, be found satisfactory. It may be asked, what is the advantage of the form suggested over the ordinary burette with supply tubes? The answer is, it does away with the necessarily oft-repeated filling of the burette, and there is but one mark to watch in making the measurement—that previously mentioned, on the test-tube. The tubing used is of such size that a rapid discharge is insured, the time required being less than would be the case were a burette employed.

MERCURIC CHLOROTHIOCYANATE.

By Charles H. Herty and J. G. Smith.

Received August 8, 1896.

IT has been shown by one of us[1] that the so-called compound lead iodochloride, PbICl, is not a true chemical compound, but a mixture of lead iodide and lead chloride.

It has seemed advisable, therefore, to study more fully the nature of the compound mercuric chlorothiocyanate, HgCl(CNS), described by McMurtry.[2] To this end a series of solutions was prepared, in one of which was used the exact proportions of mercuric thiocyanate and mercuric chloride given by McMurtry for the preparation of mercuric chlorothiocyanate; in the other members of the series, arbitrarily taken quantities of the one salt were replaced by equivalent quantities of the other. The

[1] *Am. Chem. J.*, **18**, 290.

[2] *J. chem. Soc.*, *1889*, 50.

mixed salts were completely dissolved in hot water and the solutions allowed to cool and crystallize. The quantities actually used were :

Name.	Mercuric thiocyanate.	Mercuric chloride.	Water.
	Grams.	Grams.	cc.
A	9.5000	3.1439	2000
B	6.7500	65.5004	750
C	5.5000	6.5715	550
D (McMurtry)	5.0000	7.0000	450
E	4.5000	7.4285	350
F	3.5000	8.2853	300
G	1.0000	10.4296	200

On cooling, crystals separated from all of the solutions except *G*. The crystals from *A*, *B*, *C*, and *D* were fern-shaped, while those from *E* and *F* were prismatic.

By evaporating the solution *G* one-half, quite a good crop of prismatic crystals was obtained. The crystals from all of the solutions were separated from the mother-liquor by filtration and rapid pressing between folds of drying paper.

From the mother-liquor of *D* two crops of prismatic crystals were obtained by evaporating to one-half and then to three-fourths of original volume. These were designated *D'* and *D''*.

The character of the various crops of crystals was determined by estimating the mercury present in each. This was done by reducing the compounds with sodium peroxide, as recommended by Schuyten,[1] and weighing the mercury. Analysis showed :

	Mercury found, per cent.	Mercury calculated for Mercuric thiocyanate, per cent.	Mercuric chlorothiocyanate, per cent.	Mercuric chloride, per cent.
A	62.72	63.28	68.12	73.85
B	62.76	....	....	....
C	62.74	....	....	....
D	63.91	....	....	....
E	68.24	....	....	....
F	68.67	....	....	....
G	72.59	....	....	....
D'	....	68.45	....	....
D''	....	....	72.41	....

These results show that the various crops of crystals fall into three classes, mercuric thiocyanate, mercuric chlorothiocyanate, and mercuric chloride. This was confirmed by inspection with

[1] *Chem. Ztg.*, 20, 239.

the microscope. Further, the three successive crops of crystals from solution *D* are seen to be the first mercuric thiocyanate, slightly contaminated by mercuric thiocyanate, as proved both by the high analytical result and by microscopic inspection, the second crop is mercuric chlorothiocyanate, and the third mercuric chloride.

The low results in the case of the pure salts is undoubtedly due to the fact that the filters containing the reduced mercury were dried at the ordinary temperature with consequent slight volatilization of mercury.

The effect of crystallization upon the salt mercuric chlorothiocyanate was next tried. A portion of the salt was dissolved in hot water just sufficient for complete solution. On cooling crystals separated, which, under the microscope, were seen to be only mercuric thiocyanate. The mother-liquor from these, on evaporating one-half, yielded only mercuric chlorothiocyanate. On evaporating the mother-liquor from this last two-thirds the crystals formed are seen to be a mixture of crystals of mercuric chlorothiocyanate and mercuric chloride. Finally, on evaporating this mother-liquor to dryness spontaneously, only crystals of mercuric chloride were obtained. The substance therefore undergoes dissociation when dissolved in water.

From all of the above it would seem that mercuric chlorothiocyanate is a true chemical compound, and further, that the only compound which can be prepared from solutions of mercuric chloride and mercuric thiocyanate is that represented by the formula $Hg<^{Cl}_{CNS}$ or $HgCl_2.Hg(CNS)_2$.

These results varying so widely from those obtained in the case of lead iodochloride suggest the question: is the difference due to the fact that in the one case we have the more closely related groups, iodine and chlorine, while in the other we have the more different groups, thiocyanogen and chlorine, or is the difference due to the fact that in the one case we have a lead compound while in the other a mercury salt? To test this point work will be begun at once on mixtures of lead chloride and lead thiocyanate.

UNIVERSITY OF GEORGIA.

[CONTRIBUTIONS FROM THE CHEMICAL LABORATORY OF CASE SCHOOL OF APPLIED SCIENCE.]

XXIV.—COMPOSITION OF AMERICAN KAOLINS.

BY CHARLES F. MABERY AND OTIS T. KLOOZ.[1]

Received July 22, 1896.

ALTHOUGH great advances have been made in recent years toward a better knowledge of American clays and suitable methods for the manufacture of ware from them, much more extended investigation is necessary, both concerning the composition of the great clay deposits and in the details of manufacture. The first and most essential information is a correct knowledge of the composition of all clays available for use. Of scarcely less importance is masterly skill in the purification of crude materials, shaping the ware and burning. In the preparation of materia lsit is questionable whether American manufacturers can wait patiently several months for the slow processes of lixiviations and kneading that European porcelain makers have found indispensable in the production of the finest porcelain. The great porcelain factories in Europe are founded on the application of scientific skill and a personality in shaping and burning, handed down by lineal descent through many generations. Is it possible to procure for American factories scions for those ancient families, or must we wait for its perfection by our own ready facility and ingenuity?

As already mentioned, the porcelain manufacturer must be perfectly familiar with the composition of all materials within his reach. In making suitable mixtures he must have before him as one of the most essential features of composition, the proportions of free and combined silica, as well as the percentages of lime, iron, alkalies and water.

Having at hand a collection of clays, including representatives of American deposits, as well as several specimens from famous factories in Germany, it seemed of interest to compare the composition of clays from different sources. For the manufacture of the finest porcelain, the kaolin used in the Royal Berlin factory, at Charlottenburg, may be accepted as a standard of comparison. As every one knows who is familiar with the

[1] This work was offered by Mr. Klooz in a thesis for the degree of Bachelor of Science.

qualities of true porcelain, the products from this factory are approached by no other in the world. The composition of the kaolin used in the manufacture of this ware is shown by the following analysis of the clay, two specimens selected at different times, from great quantities within the Berlin factory.

	I.	II.
Combined water	6.00	7.65
Silica	72.16	65.70
Alumina	20.05	24.49
Iron	0.10	1.03
Lime	1.14	0.60
Magnesia	0.02	0.26
Sodium oxide	0.12	0.23
Potassium oxide	0.41	0.03
Free silica	49.84	44.93

The different percentages in these analyses indicate that some latitude is permissible, although a high percentage of silica is evidently essential. These analyses show nearly the same composition as is given in the numerous analyses of the most celebrated clays of the German factories, especially in the low percentages of lime, iron and alkalies, and the large proportion of silica. An analysis of biscuit ware from the same factory shows nearly the same composition. Apparently the clay has the required proportion of silica without further addition :

Silica	68.24
Alumina	29.16
Iron	0.10
Lime	1.18
Magnesia	0.12
Alkalies	0.17
Free silica	57.50

Of the American clays, analyses showed that some contained a considerable excess of silica above the amount required for the oxygen ratio of silica to that of the alumina, 2 : 1, or the formula $Al_2O_3.3SiO_2$, which is accepted in the manufacture of the best German ware ; others only a small excess of silica. Of the high silica clays, a specimen from a deposit in Maryland gave the following results :

Combined water	11.23
Silica	47.60
Alumina	37.38
Iron	1.66
Lime	1.50
Sodium oxide	0.22
Potassium oxide	0.34
Free silica	17.10

Another clay of this class is a Missouri kaolin which was analyzed:

Combined water	4.15
Silica	82.64
Iron	12.41
Lime	0.05
Magnesia	0.11
Sodium oxide	0.08
Potassium oxide	0.53
Free silica	69.45

The following analysis represents another high silica clay from Black Rock, Arkansas:

Combined water	3.98
Silica	84.24
Alumina	11.50
Iron	0.08
Lime	0.52
Magnesia	0.02
Sodium oxide	trace
Potassium oxide	0.42
Free silica	69.93

Another high silica clay is from Milton Hollow, Middlesex Co., N. J.:

Combined water	5.52
Silica	75.06
Alumina	18.32
Iron	0.08
Lime	0.80
Magnesia	0.14
Potassium oxide	0.25
Free silica	59.71

A specimen of clay from a deposit in Washington, Middlesex Co., N. J., also showed a high percentage of silica:

Combined water	2.00
Silica	89.16
Alumina	5.77
Iron	0.07
Lime	0.70
Magnesia	0.12
Potassium oxide	1.29
Sodium oxide	1.31
Free silica	80.30

A clay having nearly the same composition as the specimen from the Berlin factory, is from a deposit at Hockessen, Delaware :

Combined water	6.55
Silica	71.46
Alumina	21.02
Iron	0.08
Lime	0.54
Magnesia	0.14
Potassium oxide	0.33
Sodium oxide	0.36
Free silica	53.13

It should not be inferred from the foregoing analyses that all American clays are high in silica. Some of the largest and most important deposits contain very little free silica. One of the purest kaolins is found in large quantities in Indiana, and the following analysis shows its composition :

Combined water	15.09
Silica	44.23
Alumina	40.56
Iron	0.07
Lime	0.13
Magnesia	0.10
Potassium oxide	0.10
Sodium oxide	0.15
Free silica	2.41

A clay of somewhat similar quality is found in Northampton Co., Pa. :

Combined water	11.20
Silica	48.16
Alumina	37.24
Lime	2.00
Magnesia	0.29
Iron	1.16
Potassium oxide	0.25
Sodium oxide	0.08
Free silica	2.85

A paper clay from South Amboy, N. J., Middlesex Co., gave the following results on analysis:

Combined water	13.35
Silica	43.30
Alumina	42.45
Iron	0.09
Lime	0.34
Magnesia	0.10
Potassium oxide	0.44
Sodium oxide	0.08
Free silica	3.55

A washed clay used in the manufacture of china, from New Castle, Del., gave the following composition:

Combined water	12.95
Silica	47.42
Alumina	38.42
Iron	0.08
Lime	0.70
Magnesia	0.12
Potassium oxide	0.30
Sodium oxide	0.12
Free silica	4.79

A clay in Woodbridge, Middlesex Co., N. J., also used in the manufacture of ware, is nearly pure kaolin:

Combined water	14.34
Silica	44.34
Alumina	38.09
Iron	0.15
Lime	0.96
Magnesia	0.10
Potassium oxide	1.00
Sodium oxide	0.79
Free silica	1.33

It is interesting to compare the composition of American kaolins with a standard kaolin used in England:

Combined water	13.00
Silica	46.00
Alumina	40.00
Iron	0.33
Lime	0.33
Magnesia	0.33

Several of the clays analyzed are used in the manufacture of ware. From some of these deposits specimens have been analyzed, and the results given in the "Chemistry of Pottery," by K. Langenbeck, are not essentially different from those given in this paper.

It is evident that the wide differences in the proportions of clay and silica in American kaolins render it imperatively necessary that they be taken into account in the selection of materials for the manufacture of ware. It is also evident that the United States is not wanting in an abundance of material for the manufacture of ware equal to the best foreign production.

DISCUSSION.

Wm. McMurtrie: It is an interesting fact not brought out here, that in many of the clays of New Jersey, and I think particularly from some of the deposits represented in the tables, Prof. Geo. H. Cook reported appreciable quantities of titanic oxide amounting to one-half per cent. more or less. The same constituent has been found in clays from other localities which I do not now exactly remember, but I have been led to believe that the existence of titanic oxide may be expected in a good many American clays.

W. A. Noyes: I have analyzed a number of Indiana clays and have found titanic oxide with but one exception. The Indiana clay given corresponds closely with one I analyzed last fall, and that particular one is free from titanic oxide, or practically so. All the other clays, and I feel safe to say that all these clays must contain titanic oxide.

The President: Does anyone know the effect of titanium on the ware?

A. A. Breneman: My impression is that Seger says there seems to be a connection between the peculiar light gray of salt-glazed stoneware, a color which is unique, and the presence of titanium. That is a very interesting statement, because that peculiar form of whitish or bluish gray stoneware is very characteristic, and I see nothing in the presence of iron alone in the clay sufficiently to account for it.[1]

[CONTRIBUTIONS FROM THE CHEMICAL LABORATORY OF CASE SCHOOL OF APPLIED SCIENCE.]

XXV. COMPOSITION OF CERTAIN MINERAL WATERS IN NORTHWESTERN PENNSYLVANIA.[2]

BY A. E. ROBINSON AND CHARLES F. MABERY.

Received July 26, 1896.

THE therapeutic qualities of mineral springs throughout northwestern Pennsylvania have long been recognized, and recently some of these springs, notably those at Saegertown and Cambridgeboro, have come into prominence through the enterprise of persons interested in hotels and sanitariums. The desirable qualities of these waters are doubtless dependent on

[1] NOTE ON TITANIUM IN CLAYS.—In the course of a discussion of Prof. Mabery's paper on American clays at the Buffalo meeting I alluded to the peculiar color of salt-glazed stoneware, and ascribed to Seger the suggestion that it was due to the presence of titanium. On referring to Seger's article (Wagner's Jahresbericht, 1883, p. 625), I find that he says that titanic acid (13.3 per cent.) heated with a very pure kaolin to a temperature between the melting points of wrought iron and platinum fuses, and that titanic acid is, under similar conditions, more of a flux for clay than silicic acid is. In the proportion of 6.65 per cent. of TiO_2, the mass became only semi-fused, and exhibited a dark-blue gray color. He says this color suggests the tint given by many clays when strongly heated.

Morgenroth (Wag. Jahr., 1884, 638) says, however, that rutile gives to clay ware a gray color under the glaze when impure ferruginous clays are used, but a yellow, ivory-like tint with pure clays. As rutile was used in the proportion of only 0.4 per cent., the minute proportion of iron which it carries (1.5 to 2.4 per cent. Fe_2O_3) would have little effect.

The interpretation of these facts to explain the peculiar gray color of salt-glazed stoneware, was probably a suggestion of my own, made at the time of reading these articles a dozen years ago. It was ascribed in the course of the discussion to Seger, as my "impression."

Nevertheless, in view of the peculiarity of this color, the gray of salt-glazed ware which is uniform throughout the body and becomes more bluish in overburned pieces, and in view also of the presence of iron in the rather crude clays used for the ware, and the fact that iron alone tends to escape as volatile chloride in presence of the salt used for glazing, the suggestion is worthy of note. A. A. BRENEMAN.

[2] This work, with a study of the methods of analysis, was offered by Mr. Robinson in a thesis for the degree of Bachelor of Science. Read at the Buffalo Meeting, August, 1896.

iron and certain other salts, especially on the bromides, and it is a popular view that lithium salts sometimes present impart valuable medicinal qualities. A quantity of water was collected from one of these surface springs at Conneautville by one of us (Robinson) and its composition as shown by analysis may serve as a representative of the springs in this region. The total solids in this water is equivalent to 6.586 grains per imperial gallon, or 9.83 parts per 100,000. Evidently the combination of bases and acids is to a certain extent arbitrary, but this distribution accounts for the total quantities of the various elements given by analysis:

	Grains per gallon.
Potassium carbonate	0.985
Lithium carbonate	0.002
Sodium chloride	0.925
Calcium bicarbonate	2.879
Calcium sulphate	1.291
Magnesium chloride	0.204
Ferrous carbonate	0.743
Silica	0.233
Hydrogen sulphide	trace

The specific gravity of this water was found to be 1.0002 at 20°. Evidently the analysis shows the composition of a good potable water. Any medicinal qualities it possesses must be referred to the iron and perhaps to a less extent to the lithium.

At greater depths in this section of Pennsylvania and in certain portions of Ohio, water may be found that partakes in a greater degree of the qualities imparted by the constituents of bittern. Wells sunk to depths of 1,000 to 3,000 feet have penetrated strata enclosing, frequently under great pressure, large quantities of bittern waters. While in general conforming in composition to the salts contained in bittern, occasionally these wells have yielded peculiar results on analysis. Such an aqueous stratum was reached several years ago at Conneautville, Crawford County, Pa., in an endeavor to obtain oil or gas. The drill penetrated the formation enclosing water at a depth of 2,667 feet and the drilling tools were forced upwards to a height of 1,800 feet by the water which prevented further drilling. This

level was maintained notwithstanding vigorous attempts to clear the well by pumping. A slight examination then showed that this water possessed peculiar qualities, but the well received no further attention until within a few months ago when it was cleared and a quantity of the water was procured for a more thorough examination. The total solids is equivalent to 21,334.34 grains per gallon or to 30,536 parts per 100,000. The specific gravity of the water is 1.205 at 15°. Its composition as shown by the results of analyses is as follows:

	Grains per gallon.	Parts per 100.000.
Potassium chloride	528.577	755.6
Lithium "	56.422	80.3
Ammonium "	151.879	216.6
Sodium "	9902.578	14430.0
Potassium bromide	137.010	245.7
" iodide	2.078	2.96
Magnesium chloride	2172.499	3096.0
Calcium "	8335.537	11880.0
" sulphate	7.886	11.1
Ferrous carbonate	114.836	163.5
Aluminum chloride	21.816	31.1
Silica	3.220	4.6
Hydrogen sulphide	0.033	0.05

There are certain features of this water that deserve especial mention. The large proportion of ammonium chloride is quite unusual in waters from such depths. Lithium chloride is frequently found in surface springs, and in brines from deep wells, but rarely, if ever, in such quantities as this water contains. If lithium salts impart to spring water the therapeutic qualities claimed for them, it is not difficult to account for the beneficial effects that have been observed in the use of this water. No doubt the large proportion of potassium bromide has much to do with the marked sedative effect. The large percentage of potassium iodide is also phenomenal, and it must intensify the mineral characteristics of the water. Besides the characteristics of a bromo-lithia water the large percentage of iron assures the desirable qualities of an iron water. The peculiar composition of this water, especially in the large quantities of the rarer elements, offered a favorable opportunity to ascertain whether these

bittern deposits contain also the elements, cesium and rubidium, which are rarely found in springs. Forty-five liters of the water were evaporated to a small volume, removing the great quantities of salt as they separated. When the volume was reduced to less than fifty cc. this solution as well as the lixiviated salts that had separated during evaporation were carefully examined in the spectroscope. But not a trace of rubidium nor cesium could be detected. It is therefore safe to conclude that the bittern deposits from the ancient sea do not contain these rarer elements.

It may not be out of place to remark that the chemical composition of this water explains the remarkable therapeutic qualities especially for rheumatism and nervous diseases that it has been found to possess.

SOME ANALYTICAL METHODS INVOLVING THE USE OF HYDROGEN DIOXIDE.[1]

By B. B. Ross.

Received August 31, 1896.

THE use of hydrogen peroxide as a laboratory reagent, although originally restricted to a few operations of minor importance, has within recent years met with a much wider extension, and its numerous applications in both qualitative and quantitative analysis, render it at present almost indispensable in every well-equipped analytical laboratory.

Among the more interesting applications of this substance in quantitative estimations are those which are based on the reaction which takes place when an excess of hydrogen dioxide is brought in contact with an acid solution of chromic acid, and Baumann[2] several years since described quite fully a number of analytical processes growing out of the reaction referred to.

In the process for the estimation of chromic acid in soluble chromates as outlined by Baumann, the substance under examination is first brought into a state of solution, and the not too concentrated liquid is transferred to a generating flask of special construction.

[1] Read at the Buffalo meeting, August 22, 1896.

[2] *Ztschr. anal. Chem.*, **31**, 436.

Ten cc. of dilute sulphuric acid are next added, after which from five to ten cc. of commercial hydrogen peroxide are run in from a small closed vessel connected with the generating flask, while the oxygen which is evolved, after the vigorous shaking of the contents of the flask, is collected over water in an azotometer.

The following equations given by Baumann illustrate the chemical changes connected with the above described reaction :

$$K_2Cr_2O_7 + H_2O_2 + H_2SO_4 = K_2SO_4 + 2H_2O + Cr_2O_7 ;$$
$$Cr_2O_7 + 3H_2SO_4 + 4H_2O_2 = Cr_2(SO_4)_3 + 7H_2O + O_8.$$

From these equations it will be seen that for two molecules of chromic acid or one molecule of potassium dichromate, there are evolved eight atoms of oxygen, giving an equivalent of 445.3 cc. of oxygen (measured at o° C. and 760 mm. pressure) for each gram of chromic acid which may be present.

The writer, soon after the appearance of the original article by Baumann, made a number of experimental tests of this method with a view to applying it to some other analytical processes, and still more recently has conducted a series of tests for the purpose of determining the adaptability of Baumann's method to the indirect volumetric estimation of iron.

In the dichromate method for the volumetric determination of iron, as commonly employed, the end point of the oxidation process is ascertained by the reaction with potassium ferricyanide.

As the end of this reaction is almost invariably difficult to determine, particularly if zinc has been employed as a reducing agent, the dichromate process has met with but limited application.

In order to apply the principle of the chromic acid method of Baumann to the estimation of iron, an excess of dichromate solution was employed in all of the tests and experimental determinations, the amount of the excess of chromic acid being determined by the volume of oxygen evolved upon treatment with hydrogen dioxide.

The mode of procedure adopted was as follows :

A dichromate solution was prepared by dissolving 4.913 grams

of C. P. crystallized potassium dichromate in water and diluting to a bulk of one liter.

The iron solution employed in standardizing the dichromate and permanganate solutions was obtained by dissolving iron wire in dilute sulphuric acid, the solution being reduced with metallic zinc, as usual, previous to titration.

The dichromate solution was also titrated against a freshly prepared solution of ammonium ferrous sulphate, the strength of which had been determined by titration with permanganate solution, which had also been carefully standardized by means of iron wire.

In order to ascertain the strength of the dichromate solution by the hydrogen dioxide method, about fifteen cc. of the dichromate solution is run into the generating flask above referred to, and there is also added an amount of ferric sulphate solution (free from ferrous sulphate) equivalent to about 0.06 to 0.10 gram of iron. The object of employing the ferric sulphate in this standardization is to supply approximately the same conditions as obtain in the process for the actual determination of iron.

The amount of oxygen given off from chromic acid in the presence of ferric sulphate is slightly less than that evolved when ferric sulphate is absent, but the amount of ferric iron present may vary considerably without affecting the volume of oxygen liberated.

To the contents of the generating vessel about ten cc. of dilute sulphuric acid are now added, and the flask is then connected by means of a rubber tube with a Schulze's azotometer, which has been filled with water to the zero point.

From five to ten cc. of hydrogen dioxide are next run in from a small closed vessel connected with the generating flask and the mixed liquid is then shaken, at first gently, and afterwards vigorously. The tube leading from the flask to the azotometer should be provided with a stop-cock, which should be closed before and opened immediately after each shaking.

The last trace of the oxygen liberated will not be disengaged until after the lapse of about five minutes, but it is not necessary to continue the shaking during the whole of this period. After

equalizing the height of the water in the two tubes of the azotometer, the volume of oxygen is noted and is easily corrected for temperature and pressure by reference to proper tables.

In order to test the strength of the dichromate solution by means of iron wire, a given weight of the wire is dissolved in dilute sulphuric acid, the solution reduced with zinc, as usual, and rapidly transferred to the generating flask (filtering, if necessary).

An excess of dichromate solution is now run in, hydrogen dioxide is added, and the oxygen is set free and collected as before described.

If a large excess of dichromate has been used in the preliminary test, duplicate tests should be made with employment of a small excess, say from two to three cc., of the dichromate.

The strength of the solution can then be readily calculated by difference, and, if necessary, the results can be checked by still further tests.

In the determination of iron in ores by this process, the solutions of ferric iron are reduced by zinc, as in the common permanganate method, and the remainder of the process is conducted just as described for the standardization of the dichromate by means of iron wire.

In addition to numerous tests of solutions of pure iron, several estimations of iron in iron ores were made by this process, the results obtained being compared with those secured by the permanganate method.

The following are the results of the tests of the iron ores referred to:

	Permanganate method. Mean of several determinations.	Dichromate method.
Iron ore No. 1	40.92	40.59 41.25
Iron ore No. 2	54.71	55.35 55.43 55.50

In the determination of iron in ores by this process, it is best, as in the case of the tests with iron wire, to employ only a small excess of the dichromate solution, after making a preliminary determination, as the results are much more accurate with a small than with a large excess of chromic acid.

While a sufficient number of determinations have not been made to ascertain the probable value of this method as an independent process for the estimation of iron, nevertheless some of the results secured would seem to warrant the conclusion that it might prove of utility as a check method, it being easy of execution and not at all time-consuming.

The following equation represents the changes which take place when the dichromate is brought in contact with the iron solution after reduction :

$$6FeSO_4 + K_2Cr_2O_7 + 7H_2SO_4 = 3Fe_2(SO_4)_3 + K_2SO_4 + Cr_2(SO_4)_3 + 7H_2O.$$

The writer has also attempted to apply the principle of the chromic acid method above described to the estimation of invert sugar, or rather to the determination of the amount of cuprous oxide thrown down from Fehling's solution in the process commonly employed for estimating reducing sugars.

The following equation represents the changes which take place when cuprous oxide is brought in contact with potassium dichromate in the presence of dilute sulphuric acid :

$$3Cu_2O + K_2Cr_2O_7 + 10H_2SO_4 = 6CuSO_4 + K_2SO_4 + Cr_2(SO_4)_3 + 10H_2O.$$

The cuprous oxide thrown down from the sugar solution under examination is brought upon an asbestos filter connected with a filter pump and thoroughly and rapidly washed with hot water. The filter and contents are next transferred to the generating flask of the apparatus before described, and after the addition of dilute sulphuric acid, an excess of dichromate is run in.

Very thorough and long continued agitation of the contents of the flask is necessary in order to effect the complete oxidation and solution of the cuprous oxide, and the hydrogen peroxide must not be added until the solution is complete.

The oxygen liberated on the addition of the hydrogen dioxide is collected and the volume noted as before described. The equivalent amounts of chromic acid, cuprous oxide and invert sugar can be easily calculated from the data thus secured.

This method, while apparently satisfactory from a theoretical

standpoint, has so far failed to give sufficiently uniform results, one of the chief objections to the process being the difficulty attendant upon the solution of the cuprous oxide.

With improvements in the details of manipulation of the process, however, it is quite possible that more satisfactory results could be obtained.

SECOND INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY.

By H. W. Wiley.

Received September 15, 1896.

At the first congress held in Brussels, in 1894, it was decided to hold the meetings bi-annually and Paris was selected as the most desirable place for the reunion this year. As has already been announced to the readers of the Journal, the present congress is organized under the patronage of the French government and under the immediate direction of l'Association des Chimistes de Sucrerie et de Distillerie de France et des Colonies. The late Professor Pasteur had accepted the honorary presidency of the congress, and all delegates from foreign countries have felt an especial regret that his death has prevented them from listening to his words of welcome and from forming his personal acquaintance.

To promote the interests of the congress, committees were organized in most countries. The personnel of the one in the United States has already been published in this Journal. Through the French Foreign Office all the principal governments were invited to send delegates to the congress. Official representatives were present from Belgium, Germany, Italy, Russia, Switzerland, Austria, Portugal, Denmark, and the United States. So far as I can learn, and the fact is worthy of remark, there is no representative in attendance from England, either official or otherwise. The official delegate from the United States is Mr. C. A. Doremus, of New York, while the writer has a commission as a delegate from the Department of Agriculture, and one from the American Chemical Society, sent through the courtesy of the president and council. Belgium has the largest representation of any foreign country, and, since these gentlemen are all French in their language, the congress, as is natural, is essentially French.

The congress was formally opened July 27, at 10 A. M., in the grand amphitheater of the Sorbonne. Perhaps there is no other spot in the whole world so well suited by its history and tradi-

tions for the seat of a scientific congress, especially of chemistry. In or near the Sorbonne were made those advances in chemical science which have made famous the names of Lavoisier, Chevreul, Dumas, Deville, Wurtz, Pasteur, Berthelot, and many others scarcely less renowned. The address of welcome was fitly made by Mr. Berthelot, rendered, by the death of Pasteur, the head and front of French science. The response was pronounced by Mr. Lindet, provisional president. After these addresses, the provisional secretary of the congress presented a report showing the activity of the French and other committees and giving the number of chemists who had become members of the congress.

The congress is organized with ten sections, as follows:

1re Section.—Sucrerie.

2e Section.—Industries de la fermentation: alcools, vins, bières, cidres, vinaigres.

3e Section.—Industries agricoles: laiterie, fromagerie, féculerie, amidonnerie, glucoserie, matières alimentaires.

4e Section.—Chimie agricole: engrais, terres, eaux résiduaires; alimentation du bétail.

5e Section.—Analyses officielles et commerciales des matières soumises à l'impôt.—Appareils de précision.

6e Section.—Industries chimiques: produits chimiques, pharmaceutiques; corps gras, caoutchouc, matières colorantes, papiers, tannerie, verrerie, céramique, etc.

7e Section.—Photographie.

8e Section.—Métallurgie, mines, explosifs, etc.

9e Section.—Chimie Appliquée à la médecine, à la toxicologie, à la pharmacie, à l'hygiene et à l'alimentation. Matières alimentaires: altérations et falsifications.

10e Section.—Électricité: électro-chimie.

The meetings of the congress are held in the Hôtel de la Société d'Encouragement de l'Industrie Nationale, 44 rue de Rennes, opposite the church of St. Germains des Prés and in the Hôtel des Sociétés Savantes, situated in rue Serpente, opposite rue Danton. Only four or five of the sections are in session at any one time, thus affording an opportunity to the members of the congress of attaching themselves to several sections.

In the afternoon of the first day visits were made to the Gobelin tapestries, the Museum of Natural History, botanical gardens, the National Tobacco Factory, and the Eiffel tower, the latter being reached by boats on the Seine. At the end of these visits a banquet was served on the first floor of the tower and from the tables a pleasing vision of Paris by night was obtained.

On the second day of the congress, an interesting paper was read by Mr. Moissan on the electric furnace. A large number

of samples of the typical compounds obtained at the intense heat of the furnace was exhibited and a description of their physical and chemical properties given. The possibilities of the electric furnace in the near future were outlined. Mr. Moissan described in some detail the construction of the furnace. It is best made by carving a block of quicklime into the proper shape. The high infusibility of the quicklime and its non-conducting power are points in its favor. The electrodes should be of the purest carbon and there should be no deflection of the arc into the crucible. The control of the current is of the greatest importance. For instance, in the case of titanic oxide it is reduced to titanous oxide with a current of thirty ampères; at 300 ampères titanium nitride is produced and at 3,000 ampères titanium carbide. Many metallic carbides, as, for instance, calcium, yield a gas when moistened, but the gases are not identical. In addition to acetylene, hydrogen, marsh gas, and petroleum have been obtained, the latter from uranium carbide. This fact is of great interest in respect of the origin of natural gas and petroleum, which, by many, are supposed to be of organic derivation. In the furnace, molybdenum and manganese are capable of forming compounds similar to cast iron. Fine samples of chromium obtained in the furnace were shown and many specimens of various nitrides, carbides, and borides. Chromium oxide was reduced to metal before the audience and silica was sublimed.

In addition to Mr. Moissan's paper, a general discussion of electrolytic problems was held including electrolytic methods of preparing chlorine, chlorinated soda, and calcium carbide.

Mr. Moissan has accepted an invitation to attend the Princeton College celebration in the autumn and has made arrangements to give some lectures in the United States. Our chemists, therefore, will have an opportunity in the near future to hear him and to note the great progress which the electric furnace has made possible in the line of discoveries in mineral chemistry.

Another discussion of unusual interest was devoted to the official graduation of instruments of precision. It was the general consensus of opinion that a uniform 100 gram weight of platinum should be adopted by all countries, and that all instruments and utensils for weight and volume should be referred to this standard. The official meter was regarded by all to be the ultimate standard of instruments to measure length. Some of the members favored a standard of brass coated with gold or platinum, in order to have an ultimate standard of greater volume than the one made of platinum. The difficulty of securing brass of uniform and definite constitution was considered as an insuperable objection to this proposition.

Among the many papers of special interest read on this day only a few can be mentioned here by title, *viz.*, Application of Electro-Chemistry to the manufacture of Chemical Products, by M. Joly; The Difficult Digestibility of Sterilized Milk, by M. Laurent; Determination of Soil Elements Assimilable by Plants, by M. Garola; Plan and Installation of an Agricultural Experiment Station, by M. Soillard.

At 4 P. M. the sections were adjourned to visit the new city hall (Hotel de Ville), which has finally been completely restored from its destruction by the Commune. There the members were received by the mayor of the city (Prefet de la Seine), the chief of police and the chief of the fire department. After enjoying a delightful collation, such as the city of Paris knows so well how to prepare, we were conducted by the mayor throughout the building and had described to us the mural decorations and the various groups of statuary. In the opinion of experts, the new Hotel de Ville is quite equal in its artistic decorations to the magnificent structure so wantonly destroyed by the Communists in 1871.

On the third day of the congress sessions of the sections were held only in the morning. A communication was presented to the second section by Mr. Chas. J. Murphy, describing a new process of fermenting maize and showing the way to a more extended use of this product in the European distilleries. Before the third section was read several papers giving the latest European processes for the manufacture of starch. Mr. Grandeau, an agronomist well known in the United States, presented a communication to the fourth section on the assimilability of phosphates. Methods of analysis of phosphates, especially those applicable to phosphatic slags were discussed by Mr. Cluss, of Halle, and by many others. The Wagner method of solution in ammonium citrate, of a definite constitution, was advocated by nearly all those taking part in the discussion. A paper on the official German method of determining iron and alumina in phosphates, was presented by Dr. von Grueber. The method of E. Glaser, as modified by Jones, is the one which the German chemists regard as the most reliable. This method has already been described in the *Journal of Analytical and Applied Chemistry*, **5**, 671. It was pointed out that analysts had received an impression that E. Glaser had acknowledged that this method was unsound. This, however, is not the case, but the impression arose by reason of a critique of the method by C. Glaser, of Baltimore. Mr. E. Glaser died soon after publishing his method and it devolved on Dr. Grueber to continue his work. The modifications of the original method, as proposed by E. Glaser,

which have been accepted by the German chemists are principally those made by Jones and with which American chemists are quite familiar. The process, as conducted by the German official chemists, is as follows:

Ten grams of the sample are dissolved in twenty-five cc. hydrochloric acid, sp. gr. 1.20, and the volume completed to a half liter. Fifty cc. of this solution, corresponding to one gram of the substance, are evaporated to half that volume in a beaker, ten cc. of sulphuric acid (one part to four of water) added and the mixture shaken. 150 cc. of absolute alcohol are added, shaken, and the beaker placed aside for three hours. The deposited calcium sulphate is separated by filtration and washed with absolute alcohol. The washing is finished when ten drops of the filtrate, diluted with the same volume of water, does not become red when a drop of a solution of methyl orange is added. The alcohol from the filtrate and washings is recovered by distillation, and the residue oxidized by bromine and hydrochloric acid, a slight excess of ammonia added and heated until the excess is expelled. This operation is very important to prevent the incorporation of magnesia in the precipitate. The residual precipitate is separated by filtration, any remaining on the walls of the beaker being washed off with cold water and a rubber-tipped tube. The whole is washed on the filter with boiling water until all traces of sulphuric acid have disappeared. The precipitate is dried, ignited and weighed and consists of the phosphates of iron and alumina. One-half of the weight of the precipitate consists of the oxide of iron and alumina.

The quantity of iron is determined by reducing the iron in fifty cc. of the first solution made, by means of zinc, and titrating the amount reduced by a solution of potassium permanganate in the usual way. The quantity of iron having thus been determined, it is calculated to oxide and subtracted from half the weight of the iron and aluminum phosphates. The difference is the alumina.

The members of the photographic section were provided with an interesting program, but the writer was not able to be present, and the total absence of any reports of the meetings in any of the daily papers, or in any other accessible form, makes it impossible to give even a summary of what was accomplished. I do not think it advisable to encumber the pages of the Journal with a complete list of the papers presented, inasmuch as the presenting of the titles of the papers would fill many pages and give but little idea of the proceedings. Moreover the published program, although extensive, does not include perhaps more than half the titles of the papers presented, and I am not sufficiently acquainted with the French way of doing things to be able to

complete the list. Only one program of papers and proceedings has been printed, and that evidently is to serve for the whole congress. The French in this particular might well imitate the practice of the American Association for the Advancement of Science in providing daily programs.

Interesting communications were presented to the ninth section on food adulteration, and Mr. Doremus read a paper on the nature of the gases contained in canned goods. He showed that these gases were chiefly hydrogen and probably the hydrogen is produced by galvano-electric action in the metals of the can. In all cases where much gas was found, the sides of the can were found deeply corroded. There was no evidence in these cases of the action of ferments and in every case the sterilization of the canned goods was perfect. Mr. Thomas Taylor sent to the section a communication on the crystals of butter fat embodying the results of his observations while chief of the Division of Microscopy of the Department of Agriculture. Mr. F. Jean read a communication on the distinction between butter and margarine as determined by his instrument, the oleorefractometer. This instrument has been carefully tested in the Chemical Division of the Department of Agriculture, and while it has been found to give valuable indications it is by no means so definitely diagnostic as its inventor claims.

Before the eighth section were presented memoirs on the methods of determining sulphur, phosphorus, nickel and carbon.

The afternoon of the third day (Wednesday) was given over to a visit to the celebrated agricultural school and experiment station at Grignon. The members of the congress traveled by railway to Versailles where carriages were provided to conduct us to Grignon. Passing the palace and garden of Versailles, we entered the forest and after two miles reached a stretch of fields which for beauty and fertility are scarcely equaled in the world. The wheat and oats harvests were going on and I was impressed with the primitive methods employed. The cradle and the sickle are almost universally used, only one reaping machine being seen in a drive of ten miles. At Grignon the tourists were received by Mr. Philippar, the principal of the school, and by Mr. Deherain, the director of the station, whose name and fame are well known to all chemists, especially those engaged in agriculture in the United States.

The experimental plots of the station were explained by Mr. Deherain, and thereafter, in his laboratory, he gave a brief explanation of the charts representing the results of the experiments for many years. After leaving the experiment station, the members of the congress were driven over the farm connected with the

school and they also inspected the barns, stables, horses and herds of sheep and cows. I noticed that much of the agricultural machinery, especially the reapers, hay-rakes and plows, were of American manufacture. The college buildings are part of an old chateau which, under the first empire, belonged to one of the marshals of France. The school at Grignon is the largest and most important of the three national colleges of agriculture. The other two are established at Montpellier and Rennes respectively. Three classes of pupils are admitted; *viz.*, internes, who pay $240 a year, demi-internes, who pay $120, and externes, who pay $80. Others known as free auditors are also admitted to all the lectures and pay $40 a year. The course of instruction lasts two years and a half and includes zoology, botany, mineralogy, agricultural geology, physics, meteorology, general and agricultural chemistry, agriculture, horticulture, arboriculture, viticulture, sylviculture, rural economy, entomology, sericulture, apiculture, technology, agricultural legislation, hygiene and military exercises. The number of pupils admitted to each class is fixed annually by ministerial decree, and is limited also in the class of internes by the number of beds. The total number of pupils, excluding the free auditors, is about 250. On the completion of the course and passing a satisfactory examination, which shall merit at least sixty-five out of a possible 100 points, the pupil receives the diploma of the National School of Agriculture, and four-fifths of the whole number thus graduating, comprising those who have received the highest marks, are excused in time of peace from all military service, except one year.

Examinations for admission to the school are competitive and include arithmetic, algebra, geometry, trigonometry, elementary physics, chemistry, zoology, botany and geology. The chemical instruction is given by Mr. Deherain and his assistants and consists of lectures and demonstrations in general and agricultural chemistry, including the chemical study of plants, soils and fertilizers. It is evident, however, that in the short time at their disposal the students can not acquire great efficiency in chemical manipulations and in fact it is not the object of the school to train agricultural chemists, but rather to provide young men with that character of instruction which will enable them to manage with intelligence and in harmony with the most advanced teachings of science, large landed estates.

Those members of the congress who did not desire to visit Grignon were offered an alternative excursion to the nickel works of Messrs. Christofle, Bouilhet and Cie., at Saint Denis. I have not been able to secure any reports of this visit.

The fourth day of the congress, July 30, was devoted exclu-

sively to the honor of the late M. Pasteur. At 9.30 in the morning, the members assembled in the chapel of Notre Dame and placed a memorial wreath on Pasteur's coffin. The body of the illustrious savant lies in an alcove near the middle of the north side of Notre Dame, the coffin scarcely visible beneath a mountain of wreaths and crowns. Not only is the alcove in which the coffin rests full of these offerings, but they have been stored, in cart-loads, in all the adjoining alcoves. They come from individuals and learned societies from all parts of the world and from nearly every municipality in France. The coffin rests here temporarily until the tomb and monument, to be erected by popular subscription from all parts of the world, are ready. The final resting place of the body of Pasteur is to be in the court of the Pasteur Institute. With bowed heads the members of the congress marched by the coffin holding only the motionless brain whose activity has done so much to advance knowledge and benefit mankind. Thence the carriages conveyed us to the Pasteur Institute where the laboratories were inspected. A collection of many compounds of historical interest, prepared by Pasteur, was on exhibition, among which were all the tartaric acids and tartrates used by Pasteur in demonstrating molecular asymmetry as displayed by the same chemical substance having opposite relations to polarized light. A large collection of original cultures of the ferments leading to the discovery of antidotes for rabies was also on exhibition. A large number of microscopes showing the specific microbes of phthisis, cancer and diphtheria attracted general interest. In the clinical rooms we were permitted to see one of the daily inoculations with antirabic serum. About thirty patients were treated in less than half that number of minutes. About two or three cc. of serum are administered by hypodermic injection to each patient. The serum is inserted in the skin on the right or left side of the abdomen, the most convenient place on account of the infrequency of nerves. Each patient receives from ten to fifteen injections on successive days. About 150 patients are received monthly, and the treatment is entirely gratuitous. Those who are able, however, usually give generously to the funds of the institute. A large collection of rabbits, guinea pigs and dogs, serving for experimental purposes, was also inspected. We were next driven to St. Cloud and through its beautiful gardens and forests to Garches, where a delightful breakfast was served at one o'clock. After breakfast a visit was made to the stables containing the horses used to furnish the anti-diphtheritic serum. There are 120 of these and all seemed to be in perfect health. Each one of these horses has been inoculated with the diphthe-

ritic poison and the blood thereafter serves as the source of the serum. Two horses were operated on as an illustration of the method of work. A large vein in the neck of the animal is opened, a tube inserted and the blood collected in a sterilized jar. So skillfully is this accomplished that scarcely a drop of blood is lost. From four to six liters of blood are collected from each animal, when the vein is closed and the horse returned to his stall. In three or four weeks he is ready to supply another quantity of blood. The jars containing the blood are placed in a cupboard for about forty-eight hours, when, if the horse has been properly inoculated, their contents will be found sharply separated into clots and serum. The serum, which is of a light yellow color, is removed by decantation and by an ingenious apparatus, which prevents all danger of infection, is bottled in vials containing ten cc. each. One horse was shown us that had furnished in the past few years several hundred liters of serum. He appeared to be good for many hundred more. The serum thus prepared is used directly by subcutaneous injection on patients suffering from diphtheria. Every appointment in these stables was such as to impress the visitors with a new and a noble idea of science, ministering thus directly to saving life and especially the lives of children. No wonder the body of him who did so much to establish the lines of investigations which, under his immediate direction, if not by his own hands, have led to such ameliorations in the sufferings of men, lies to-day in honor in one of the most magnificent churches in the world, buried under flowers and wreaths, while the memory of his work lives immortal in the hearts of the people it has blessed.

Next was inspected the national porcelain works at Sêvres, reached after a pleasant drive from Garches. The officials of the factory received the guests at the entrance and dividing the visitors into small parties each was personally conducted through the works. Beginning with the crude materials, kaolin, quartz, etc., the methods of grinding and mixing were first explained. The character of the mixing is of course suited to the nature of the object in view, the massive urns and vases having a different proportion of the several ingredients from the delicate cups and saucers. The molding of the objects was shown in detail in its three forms; *viz.*, by carving the solid moist mass, by allowing it in a pasty state to flow into moulds, and by turning the waxy mass on a table and imparting the desired form by the hands of the operator. The urns and vases are made by the first and third methods, while the thinner vessels, such as cups, etc., are made by the second method. After drying, the glaze is applied by dipping the objects in a creamy bath of the silicates serving

to form the glaze. After the glazing is fixed by firing, the objects are passed to the decorating room to receive their final colorings. After each color is applied, it is fixed by firing. The ingenious hoods used to secure an even firing of the objects were exhibited and the manner of using them shown. The construction of the large furnaces where hundreds of vases and other objects are fired at once, was described, and the furnaces cold and in action exhibited. The visit concluded with an inspection of the museum and salesrooms with their artistic and costly contents. These are known to all visitors, but the process of manufacture which was so minutely shown us is not open to the public in general. The day was finished by a drive back to Paris through the parks of Meudon and Boulogne.

Having taken the whole of the fourth day for the interesting and instructive excursions which have just been briefly described, the fifth day, Friday, July 31, was wholly devoted to the scientific work of the congress. Sections 1, 2, 4, 5, 9, and 10 held morning sessions, and 2, 3, 5, 6, 8, and 9 met in the afternoon. The time of Section 1 was devoted to a discussion of the crystallization of sugars and the methods of suppressing the molasses in the manufacture of sugar from canes and beets. The papers presented and the discussions thereon were more technical than chemical.

In the second section, the difficulties attending the detection and estimation of the higher alcohols, aldehydes and ethers in brandies and whiskies were set forth and Mr. Tavildaroff, of St. Petersburg, gave a rêsumé of the best methods of procedure.

In the third section the methods of determining phosphoric acid in soils and fertilizers were again the subject of discussion and papers on this subject were presented by Messrs. Garola and Sidersky. Mr. Lasne presented a rêsumé of his work on the detection and estimation of iron and alumina in phosphates. In section 5, papers on the analysis of fats, estimation of acetic acid in pyroligneous acid, a new method of estimating alcohol by means of the ebullioscope, and a rapid method of analyzing denaturalized alcohol were presented by Messrs. Jean, Kestner, Wiley, and Guillier, respectively.

In the ninth section, the application of the spectroscope in medico-legal cases was discussed. In connection with a discussion of the influence exerted by ptomaines on the detection of alkaloids in medico-legal cases, Mr. Doremus presented a paper entitled "Recovery of Morphine from a Cadaver Embalmed with Arsenical Solution."

The subject of the possible detection of toxines in potable

waters was also discussed and the influence exerted on them by organic matters in process of decomposition pointed out.

In the afternoon, in section 2, a paper was presented by Mr. Kayser on the properties of yeasts of different origin. A subject of interest to the wine growers of our southern states and California was a paper on the vinification in warm climates, by Mr. Dugast. The pasteurization of wines was discussed in a paper by Mr. Malvezin. Other papers of interest to wine makers were presented and discussed.

To chemists and bacteriologists engaged in the manufacture and study of butter and cheese, the proceedings in section 3 were of great interest. The best methods of disinfecting stables and creameries by chemical means were presented by Mr. Bordas. A résumê of our knowledge concerning the influence of food on the composition and character of milk and butter was presented by Mr. Martin. A general discussion of the best means of providing cities with pure milk was led by Mr. Saillard. The importance of selecting ferments in the manufacture of butter and cheese was discussed by the section, but the work done by Conn and others in the United States did not seem to be appreciated.

In section 3 a paper on the effect of impurities on the properties of metals was presented by Mr. Le Verrier, and the methods of micrographic and photomicrographic examination of metals and alloys were described by Mr. Osmond.

In section 5, Mr. Jobin presented a paper giving the data for comparing the different saccharimetric scales in use in the determination of sugar by the polariscope, and the method of securing a uniform scale was discussed by Mr. Sidersky. It was voted that a quartz plate of exactly one millimeter thickness was the most scientific standard by which to measure or fix a saccharimetric scale. The most probable value of this standard at the present time is expressed by an angular rotation of 21° 40′.

In section 8, papers were read by Mr. Lasne on the phosphate industry, by Mr. Th. Schloesing on the condensation of vapors at a high temperature, on the ammonia industry by Mr. Truchot, and several other papers of less importance.

In section 9, the subject of the analysis of urine and the determination of urea was discussed by Messrs. Monfet, Taffe, Hodencq, Vicario, Hugnei, Barthe, Girard, and Doremus, the latter describing an apparatus for the purpose, invented some time ago by himself, and also the use of bromine dissolved in sodium bromide, as proposed by Rice.

In the evening a lecture was given to the congress in the amphitheatre of the Sorbonne on color photography by Mr.

Lippmann, who has achieved an international reputation by his researches into this important process. The principles of color photography were described and illustrated by apt experiments in conjunction with a projecting lantern. The process developed by Lippmann is based on the well known properties of thin films, as, for instance, a soap bubble to show colored bands due to the relation between the thickness of the film and the length of the waves of light. Mr. Lippmann has succeeded in depositing on a glass plate superimposed films of silver of extreme tenuousness and each of these films differs in thickness for each variation of color in the object producing the photograph. When the photograph is thus constructed it happens that when it is viewed by reflected light, every color of the object photographed is exactly reproduced. A large number of these photographs, representing paintings, flowers, landscapes and persons, was projected by reflection with the most vivid verisimilitude. Perhaps the most interesting of these was the spectrum of argon, in which the blue bands were shown in perfectly natural colors and clearly defined. The photographic effect is secured by exposing a perfectly transparent sensitive plate, backed by metallic mercury, in contact with the film. The sensitive surface of the plate is turned away from the object to be photographed. The plate holder for this operation was shown and is remarkable alike for its ingenuity and simplicity. The importance of color photography, as a means of fixing objects for study, is as great as its usefulness will prove to be in preserving with all the tints of vitality the faces of friends and the beguilements of beauty.

Mr. Lippmann kindly granted to Mr. Doremus and myself a private interview after the lecture, where we had a better opportunity to examine the negatives. They resemble the daguerreotypes of forty years ago and a distinct view of the image is only obtained by inclining the plate in the proper manner to secure the reflection of the light. Unfortunately, these negatives are not capable of being reproduced as positives as in the case of ordinary photography, and we are apparently as far away as ever from multiple printing color photography.

Sixth day, Saturday, August 1. Sessions of the sections were held only in the morning and those meeting were 1, 2, 4, 6, 7, 8 and 10.

In the fourth section Mr. Kjeldahl gave a brief statement of the present methods of conducting his process for the determination of nitrogen by moist combustion. Papers on methods of detecting and preventing frauds in the sale of commercial fertilizers were presented by Mr. Petermann. A paper on the importance of international agreement in methods of agricultural

analysis was presented by the writer. A general discussion of official methods of analyzing fertilizers was carried on, and at the end it was voted that the congress collect and publish in German and French the official methods of France, Germany and the United States. Mr. Sidersky was selected as editor of this brochure.

Messrs. Roy and Jean gave a paper in section 6 on tannins, their nature and analysis. It contained little that is new to American chemists and showed a lack of familiarity with the American publications on that subject.

In section 7 Mr. Vogel presented a paper on photography in colors, and one on the same subject was presented by Mr. Vidal. These papers gave in detail the points given *en résumé* in Mr. Lippmann's lecture.

In section 9, Mr. Guichard read a paper on alcohol from a hygienic point of view.

The employment of aluminum in the construction of cooking utensils and its influence on the wholesomeness of food prepared therein was the subject of a paper by Mr. Boroma. It was shown that with proper precautions aluminum could be safely used, but that it presented few if any advantages over copper or other metals in common use.

So widely has aluminum come into use for cooking utensils that a brief abstract of our present knowledge concerning its merits may be presented. The utility of an aluminum dish, in respect to its fitness for culinary vessels, depends on the purity of the metal. A pure aluminum dish is almost if not quite as resistant to solvent effects of ordinary foods as any common metal. The impurities which do the most harm are sodium and carbon. When the aluminum contains carbon an electric current is at once set up when a suitable liquid is applied. In such cases after water, especially if it be saline, has stood in the dish for one or two weeks, the surface will be found dotted with brilliant rings, and on scraping off the aluminum the particle of carbon will be disclosed. If a strong solution of salt be used, the action may be sufficient to cause a perforation of the metal. The aluminum of commerce, unfortunately, is not very pure, and it is for this reason that so many aluminum dishes have shown a rapid deterioration. The French troops in Madagascar have been supplied with 15,000 sets of aluminum dishes, and, when a soldier has to carry his kitchen with him, the importance of lightness is not to be despised. But even granting that in cooking in aluminum dishes a small amount of alumina is introduced into the food, it has not been shown that it exercises the least harmful action on the digestion. The experience of two men

may be cited who lived for a year on food prepared exclusively in aluminum dishes without the slightest impairment of their health.

In the afternoon the members were driven in carriages to Gennevilliers, where they inspected the irrigation works, lately constructed to supplement those at Asniéres in disposing of the sewage of Paris. It has now been more than a quarter of a century since the city of Paris has been using its sewage for irrigation. The fact that in the light of that long experiment it has recently more than doubled the area under irrigation, shows that the process is considered a practical success. The sewage of Paris consists mostly of the water used for washing the streets. Water-closets are, to a large extent, connected with vaults whose contents are removed by means of wagons, pumps and closed tanks during the night. The sewage, therefore, is not so highly polluted nor so rich in fertilizing materials as might have been supposed. For summers like the present one, which has been excessively dry, the disposal of the sewage by irrigation is easily accomplished. But in summers of excessive rainfall and in the winter, the problem is much more complex.

We first were shown a plan on a large chart of the system of sewers and the distribution of the waters. Next the pumping house was visited where the sewage is raised to a sufficient height to carry it under the Seine by a siphon aqueduct and distributed to the irrigated fields. The fields which were inspected are only a part of the vast system of irrigation now in operation. They contain 799 hectares, a part of which was once covered by the old forest of St. Germain. The city of Paris spent 200,000,000 francs in the purchase of the grounds, the building of the aqueduct, erecting the pumping machinery and building the irrigating canals. The work on the aqueduct of Achéres was commenced in 1893 and the whole work was completed in 1895. The aqueduct is eleven kilometers long and is three meters interior diameter, and it crosses the Seine, which below Paris forms a loop, twice. Fortunately, the soil, forming the basin of the Seine in this locality, is of a sandy nature and permits a somewhat rapid filtration. A clay subsoil would render the whole process inapplicable. The gardens, though only two years old, presented a scene of almost tropical exuberance. Many dwarf fruit trees were already in bearing and older trees showed the existence of orchards before the present system was inaugurated.

The methods of irrigation are exactly those practiced in the arid regions of the United States. The water is conducted in furrows on the surface between the rows of growing crops. Aside from a slightly unpleasant odor arising from the sewage, there is nothing in the scene to cause the observer to look on

the perfect vegetables and flowers with suspicion. In harmony with the French devotion to art, the borders of all the plots are planted in roses and other flowers and these, at the time of our visit, were all in full bloom, recalling in their floral exuberance the gardens of California. Here, as a result of the applications of science, typhoid fever is turned into turnips, dysentery dances in the dew on the dahlias, and cholera comes chortling as cabbage. The one unpleasant reflection is found in the fact that this extensive harvest is sold exclusively in the Paris markets and one can hardly avoid thinking in the restaurants over his cauliflower and artichoke of the long race they may have run in the aqueduct of Achêres. At the end of the experimental field, next to the river, the sewage which has passed through the soil reappears as a large stream of pure water, absolutely colorless and bright. Glasses of the attractive fluid were offered the visitors, many of whom, unmindful of miasm and microbes, drank, willing martyrs to science or curiosity. The number of micro-organisms, which is many millions in the sewage, is diminished to 2,500 in each cubic centimeter of the filtered water.

Seventh day, Sunday, August 2. An excursion was offered to the members of the congress on Sunday to Compêigne. On reaching the station, a band of music welcomed the excursionists. They were driven through the gardens and forests in carriages and at one o'clock a breakfast was served.

Eighth day, Monday, August 3. In section 1 papers were presented on the methods of determining water in organic viscous liquids, by Mr. Pellet. The process recommended is by absorption with pumice stone and subsequent drying, first at 60° to 80° and finally at 100°. Molasses and solids should first be dissolved in water to promote absorption by the pumice. A drying dish was exhibited with a circular depression in the center, into which the body is weighed and mixed with enough water to make it flow easily. The fragments of pumice are placed on the flat bottom of the dish, exterior to the depression, and the dissolved mass is absorbed by the pumice on inclining the dish. The dish and cover are made of aluminum. The diameter of the dish is about seven and its depth two cm. The composition of molasses derived from the sugar cane was discussed at some length. Raffinose, to the extent of three per cent., has been detected in samples of cane molasses of Egyptian origin. The reducing sugar, in cane molasses, according to the statement of Pellet, is composed solely of invert sugar, a conclusion which he has reached by applying the method of estimating levulose described by the writer in this Journal a few months ago.[1]

[1] Vol. 18, No. 1, p. 81.

An interesting paper by Mr. Herzfeld, of Berlin, gave a résumé of the best methods of separating sugars in mixtures.

In section 3, the session was devoted to the chemical study of processes of bread making, and especially to the methods of analysis of moist and dry gluten. The processes presented are almost identical with those in use in the United States. Mr. Lindet, the president of the congress, read a communication on the methods of determining starch in grains and flours, in which the separation by a ferment or by water under steam pressure was recommended as the best. These are the processes which we have preferred for several years in the agricultural laboratory at Washington.

In section 6, papers were presented on gutta percha, paper, and paint used to prevent corrosion of ship bottoms.

In section 9 a paper on the analysis of wines and vinegar was presented by Mr. Leroy. The detection of glucose in beer was discussed by Mr. Padé. The question of fermentation and the germicidal methods of controlling it by means of fluorides was discussed by Mr. Effront.

An interesting exhibition was given of the workings of the latest form of bomb calorimeter for the determination of the thermal equivalents of foods.

Among the more interesting papers presented in the afternoon may be mentioned one by Mr. Fernback, director of the laboratories of the Pasteur Institute, on the utilization of the carbon dioxide arising from fermentation, in section 2; the influence of culture on the chemical and physical properties of the soil, by Mr. Deherain, in section 4, and the estimation of lactose and sucrose in condensed milks, by Mr. F. Dupont, the general secretary of the congress, in section 5.

In the evening a banquet was given to the chairmen of committees of organization and to the delegates of foreign governments, in the Salle des grandes Fêtes of the Grand Hotel, under the presidency of Mr. Cochery, Minister of Finance, at which nearly 500 sat down. An orchestra rendered beautiful music during the repast, giving among other things the national airs of the various governments represented. "Yankee Doodle" doubtless was heard with equanimity, but one can imagine the feelings of the Frenchmen present when "Die Wacht am Rhein" was given. Short addresses were made by Mr. Lindet, the president of the congress, by Mr. Doremus, on the part of the foreign delegates, and a rather long one by the Minister, who greeted the chemists for many reasons, and especially, he said, "because you are the precious auxiliaries of my department in promoting the production of articles that can be taxed." Mr. Doremus introduced his address by quoting one of the inscriptions on the statue

of Danton: "Apres le pain l'education est le plus grand besoin du peuple." He alluded to the addresses of Berthelot, Moissan, and Lippmann, as illustrations of a few of the accomplishments of applied chemistry, and said the congress had shown in a striking manner the necessity of a close alliance between applied and research science. Pasteur will owe his immortality to the great faculty he possessed of finding a practical application for his discoveries. He concluded as follows: "Hon. Minister of Finance, representing the French Republic, M. Berthelot, the illustrious president of honor of this congress, M. Lindet, the president of the congress, M. Dupont, the secretary, I wish to thank you in behalf of the foreign delegates, for the hospitality, friendship, and good fellowship with which we have been received. In the name of the foreign delegates, I propose this toast, the French Republic, patron not only of this congress, but also of science, art and industry, the mother of men famous in each science, but especially in chemistry."

The strangers present were given a very favorable opportunity to understand the heartiness of French hospitality and the excellence of French cooking. We might learn more things than good cooking from a French banquet and among others the art of limiting the post prandial speeches. At ten o'clock the guests left the table and assembled in the grand salon, where coffee and liqueurs were served and an hour or more spent in social intercourse.

Ninth day, Tuesday, August 4. I have already used so much space in giving even a few of the details of the congress that it is not advisable to mention even the more important communications presented to-day. Morning sessions only were held. In the afternoon the Conservatoire des Arts et Métiers was visited, where the congress was received by Mr. Aimé Girard, the professor of applied chemistry, and shown through the laboratories and museums. In the latter alone are enough objects of interest to employ the time of a scientist for a month for a careful study. We can only mention *fastigia rerum*. The pendulum used by Foucault in his classical experiments is still swinging and showing by its deflections the rotation of the earth. All the important apparatus used by Lavoisier is collected here. The globes employed by him for determining the composition of water are remarkably well made and even to-day would be regarded as entirely convenient. But they have their chief value as the remains of those era-making investigations, cut short by the guillotine, which laid the foundation of modern chemistry. A wooden wheel, preserved by the copper sulphate in an abandoned copper mine since the fifth century, illustrates in a most

striking way one of the best methods of preventing decay in railroad ties. The standard measures of all nations make an interesting collection, but, unfortunately, we were not permitted to see the original meter, which is preserved from view in the vaults of the building. In the courtyards are bronze statues of Le Blanc, who made the fortunes of so many and committed suicide by reason of his own poverty, and of Boussingault, the contemporary of Liebig and the father of French agricultural chemistry. A photographic view of the congress was made on the steps of the west façade of the building.

Tenth day, Wednesday, August 5. In the morning the sections held their final sessions for hearing papers and discussions. In the afternoon the closing meeting of the congress was held in the grand amphitheatre of the Sorbonne under the presidency of Mr. Henri Boucher, Minister of Commerce and Industry. Addresses were made by Mr. Lindet and the Minister and a report of the proceedings of the congress presented by the secretary, Mr. Dupont. Turin and Vienna were placed in nomination as the places of meeting of the congress in 1898. Vienna was selected by a large majority. An invitation was extended by Mr. Lindet to hold the congress of 1900 in Paris during the World's Exhibition, and that invitation will doubtless be accepted at Vienna.

After the adjournment of the meeting, the new laboratories of organic chemistry, constructed by Friedel, were inspected by Mr. Doremus and myself. In the confusion of the summer cleaning, we could hardly form any favorable judgment of their points of excellence. The ultra impressionist painting of Paradise Lost, a mural ornamentation back of the professor's lecture table, was the most original and inexplicable feature of the laboratory.

PARIS, August 10, 1896.

NOTE.

The fourteenth annual report of the Committee on Indexing Chemical Literature was presented to the American Association for the Advancement of Science at the Buffalo meeting, August 24. A large amount of work has been done in this field during the year. The committee is an active one and has done a valuable work in encouraging and recording biographical undertakings. Copies of the report may be obtained of the chairman, Dr. H. Carrington Bolton, Cosmos Club, Washington, D. C.